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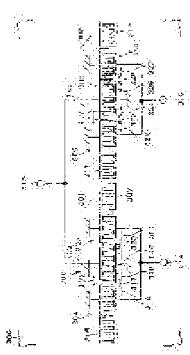
(54) SURFACE ACOUSTIC WAVE DEVICE, AND COMMUNICATION DEVICE CONTAINING THE SAME



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surface acoustic wave device with a

simple configuration by which balanced-unbalanced coversion is performed while suppressing the deterioration of insertion loss, and impedance is set one-to-two or one-to-three between unbalance and balance.
SOLUTION: A surface acoustic wave device includes a plurality of interdigital electrode portions 303, 304, 305, 308, 309, and 310 provided so as to have a balanced-to-unbalanced conversion function. A ratio N2/N1 is the range of about 50% to about 70%, where N1 represents the total number of electrode fingers of the interdigital electrode portions 304, 305, 309, and 310 connected on the side of a balanced signal terminal 314, and N2 represents the total number of electrode fingers of the interdigital electrode portions 303, and 308 connected on the side of an unbalanced signal terminal 313. The meshing width (W) of the interdigital electrode portions 303, 304, 305, 308, 309, and 310 is in the range of about 43 λ to about 58 λ in which λ is the wavelength of a surface acoustic wave.

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CLAIMS

[Claim(s)]

[Claim 1]

In the surface acoustic wave equipment equipped with two or more comb mold polar zone so that it might have balanced - unbalance conversion function, When it connects and turned on the balanced signal terminal side, the electrode **** number of the mold polar zone was connected and made into the N1 and unbalance signal terminal side and it considers as the electrode **** number N2 of the mold polar zone, Surface acoustic wave equipment which ratios N2/N1 are 50% - 70%, and is characterized by setting the electrode decussation width of face (W) of said comb mold polar zone as the range of 43lambda-58lambda to the wavelength lambda of a surface acoustic wave.

[Claim 2]

Surface acoustic wave equipment according to claim 1 with which the pitch of the electrode finger with which the comb mold polar zone which adjoins a reflector among said comb mold polar zone, and said reflector adjoin each other in the part which adjoins each other mutually is characterized by being 0.46lambdar-0.54lambdar to electrode period lambdar of said reflector.

[Claim 3]
Surface acoustic wave equipment according to claim 1 or 2 characterized by setting up the frequency fidt decided by the electrode period of said comb mold polar zone in =(fref/fidt)0.993-1.008 to the frequency fref decided by the electrode period of said reflector.
[Claim 4]
The 1st three or more surface acoustic wave filters which was formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate and which goes away odd pieces and has the mold polar zone, It has the 2nd surface acoustic wave filter with which the phases of an output signal differ about 180 degrees to an input signal. The terminal in the said 1st and 2nd surface acoustic wave filter which is one side, respectively is electrically connected to juxtaposition. Surface acoustic wave equipment given in claim 1 characterized by having balanced - unbalance conversion function by using as a balanced signal terminal the terminal which connected to the unbalance signal terminal and the serial the terminal which connected another side to the serial electrically and was connected to said juxtaposition thru/or any 1 term of 3.
[Claim 5]
Surface acoustic wave equipment given in claim 1 characterized by connecting the comb mold polar zone of [(k-1) /2] individual to an unbalance signal terminal, and connecting the comb mold polar zone of {[(k-1) /2]+1} individual to a balanced signal terminal, respectively when setting the number of comb mold polar zone to k thru/or any 1 term of 3.
[Claim 6]
In one surface acoustic wave filter formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate Have the 1st terminal with which the difference of the phase of an output signal becomes about 0 times to an input signal, and the 2nd terminal with which the difference of the phase of an output signal becomes about 180 degrees to an input signal, and the 1st terminal of the above, and the 2nd terminal by connecting with a serial mutually Surface

acoustic wave equipment given in claim 1 characterized by having balanced - unbalance conversion function thru/or any 1 term of 3.

[Claim 7]

Two or more three comb mold polar zone is surface acoustic wave equipment given in claim 1 characterized by being prepared in the vertical joint resonator mold filter which goes away and has the mold polar zone thru/or any 1 term of 6.

[Claim 8]

Surface acoustic wave equipment given in claim 1 thru/or any 1 term of 7 characterized by connecting electrically at least one surface acoustic wave resonator to the comb mold polar zone connected to a balanced signal terminal side at least at the serial.

[Claim 9]

The exciting frequency of standing wave resonance mode which has the peak of the intensity distribution of a surface acoustic wave for the exciting frequency in zero-order mode between f0 and the comb mold polar-zone-comb mold polar zone among the resonance modes in each comb mold polar zone is set to fN. When resonance frequency of a surface acoustic wave resonator is set to f1 and antiresonant frequency is set to f2, Surface acoustic wave equipment according to claim 7 characterized by connecting electrically at least one surface acoustic wave resonator to the terminal connected to the comb mold polar zone located in both ends at least at the serial, respectively so that it may become $f1<f0<fN<f2$.

[Claim 10]

Surface acoustic wave equipment given in claim 1 thru/or any 1 term of 9 characterized by being set up so that the relation to 1:2 thru/or 1:3 of the impedance of an unbalance signal terminal and a balanced signal terminal may become.

[Claim 11]

The communication device characterized by having surface acoustic wave equipment of a publication in claim 1 thru/or any 1 term of 10.

[Translation done.]

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to the communication device which has the surface acoustic wave equipment used suitable for the filter of small radio communication equipments, such as a cellular phone, especially balanced - unbalance conversion function, and has the surface acoustic wave equipment and it from which an I/O impedance differs.

[0002]

[Description of the Prior Art]

In recent years, the technical progress over the miniaturization of small radio communication equipments, such as a cellular phone, and lightweight-izing has a remarkable thing. As a means for realizing this, development of the components which compounded the function of plurality [miniaturization / reduction of each component parts and] from the first has also progressed.

[0003]

The demand to having balanced - unbalance conversion function and the function of the so-called balun against the background of such a situation to the

surface acoustic wave filter used for RF stage of a cellular phone is becoming strong, and the vertical joint resonator mold surface-wave filter which can respond balanced - unbalance signal transformation easily is becoming in use as a band pass filter of RF stage of a cellular phone.

[0004]

It connects with the mixer IC equipped with a balance or differential I/O (henceforth the balanced type mixer IC), and the vertical joint resonator mold surface wave filter equipped with this balanced - unbalance conversion function is used in many cases. Since reduction of the effect of a noise and stabilization of an output can be attained and improvement in a property of a cellular phone can be aimed at when this balanced type mixer IC is used, it came to be used mostly in recent years.

[0005]

In many cases, the impedance of this balanced type mixer IC has the surface acoustic wave filter as expensive as 100ohms - about 200ohms used for RF stage to usually having the impedance of 50 ohms. Especially, since the old mainstream was 200ohms, the property that an input impedance differs from an output impedance about 4 times was demanded of it by the vertical joint resonator mold surface wave filter used together with the balanced type mixer IC.

[0006]

In order to acquire the property that an input impedance differs from an output impedance about 4 times mutually, as shown in drawing 28 R> 8, the configuration currently indicated by JP,2001-267885,A is used widely. In each surface acoustic elements 101 and 102 of a vertical joint resonator mold, one side of a terminal is connected to juxtaposition and, as for the configuration of drawing 28 , one side is electrically connected to the serial.

[0007]

A point different mutually between a surface acoustic element 101 and a surface acoustic element 102 is that the comb mold polar zone (it is hereafter described as IDT) 103 and IDT108 are mutually reversed in respect of a phase. Thereby,

the phases of the signal outputted from a terminal 114 and a terminal 115 differ about 180 degrees, and are changed into the balanced signal with which the unbalance signal inputted from a terminal 113 is outputted from a terminal 114 and a terminal 115.

[0008]

Moreover, the frequency characteristics and the impedance characteristic in a configuration of drawing 28 are shown in drawing 29 , drawing 30 (a), and (b), respectively. The property of drawing 29 was designed as a filter for EGSM (Enhanced Global System for Mobile communications) transmission, and a frequency range required for a passband is 880MHz - 915MHz. The f= 880MHz point is plotted to drawing 30 R> 0 (a) and (b), using X and the f= 915MHz point as Y.

[0009]

When it designs with the configuration of drawing 1 so that drawing 30 (a) and (b) may show, an unbalance side (S11), to 50 ohms, as for the terminal impedance of 200 ohms of balancing side (S22), adjustment can be taken mostly, and, as for the impedance in a passband, the property that the impedance by the side of a balanced signal will be about 4 times the impedance by the side of an unbalance signal is acquired.

[0010]

On the other hand, although it mentions above, by the balanced type mixer IC, an impedance may be near 100ohm and the property that the impedance by the side of an unbalance signal terminal differs from the impedance by the side of a balanced signal terminal about 2 times may be required also of a vertical joint resonator mold surface wave filter according to it.

[0011]

A filter corresponding to unbalance-balance I/O like drawing 31 was constituted from a Japan patent No. 3224202 official report, and the solution is shown. If the configuration of drawing 31 is explained, it will have composition which carried out cascade connection of each surface acoustic elements 201 and 202 of two

vertical joint resonator molds to IDT204 in IDT209, IDT205, and IDT210, respectively, and the signal which a terminal 213 is an unbalance signal terminal and was inputted from the terminal 213 will be outputted to each balanced signal terminals 214 and 215 as a signal with which phases differ about 180 degrees in IDT208, respectively.

[0012]

In the Japan patent No. 3224202 official report, it is changing mutually the decussation width of face W of each surface acoustic elements 201 and 202 with the configuration of drawing 31 , and even when the impedance by the side of an unbalance signal terminal differs from the impedance by the side of a balanced signal terminal, it is supposed that a desired property can be acquired.

[0013]

[Problem(s) to be Solved by the Invention]

However, the property of being satisfied with the configuration of drawing 31 of a demand in recent years called a broadband, low loss, and high unbalance cannot be acquired. When one carries out cascade connection of each two surface acoustic elements 201 and 202, an insertion loss serves as a value for two elements with a natural thing. In order to change decussation [the 2nd step of] width of face with the 1st step moreover, the mismatching in stage Mabe occurs and an insertion loss becomes large further.

[0014]

The frequency characteristics in one surface acoustic element are used for reference, the two surface acoustic element is used for drawing 32 , and the frequency characteristics at the time of carrying out cascade connection are shown in drawing 33 . wiring [in the configuration of drawing 31 , one has composition which outputs the signal with which phases differ 180 degrees to the balanced signal terminal 214 and a terminal 215 in IDT208, but] on an IDT electrode or a substrate -- unsymmetrical -- not constituting -- since it does not obtain but the amplitude and phase unbalance of an output signal are influenced, unbalance gets worse compared with the configuration of drawing 28 .

[0015]

From the above thing, the configuration of drawing 31 is unsuitable for the filter corresponding to unbalance-balance I/O with high low loss and demand level of balancing, and the configuration of drawing 28 is used chiefly.

[0016]

Below, in the configuration of drawing 28 , an input side and the balanced signal terminals 114 and 115 are explained for the unbalance signal terminal 113 as an output side. When the impedance of the input/output terminal of surface acoustic elements 101 and 102 is set to Ri and Ro with the configuration of drawing 28 , since, as for the impedance by the side of an unbalance signal terminal, the terminal of the input side of surface acoustic elements 101 and 102 is electrically connected to juxtaposition, since the terminal of the output side of surface acoustic elements 101 and 102 is electrically connected to a serial, the impedance by the side of Ri/2 and a balanced signal terminal serves as 2Ro.

[0017]

Usually, when surface acoustic elements 101 and 102 are designed in three IDT(s), since the impedance of I/O becomes a near value, Ri**Ro is realized. Therefore, in order to constitute the unbalance-balance I/O filter with which the impedances by the side of a balanced signal terminal which was mentioned above differ about 4 times to the impedance by the side of unbalance, it becomes 4xRi/2**2Ro, i.e., Ri**Ro, and the design is easy.

[0018]

On the other hand, in order to constitute the unbalance-balance conversion function in which the impedances by the side of a balanced signal terminal differ about 2 times to the impedance by the side of an unbalance signal terminal, it is necessary to design the surface acoustic elements 101 and 102 which become 2xRi/2**2Ro, i.e., 2 Ri**Ro, and it can be said that a design top is difficult.

[0019]

The surface acoustic wave equipment which has the unbalance-balance conversion function in which the impedances by the side of a balanced signal

terminal differ about 4 times to the impedance by the side of an unbalance signal terminal in the surface acoustic element used as Ri**Ro in one of the conventional approaches is constituted. An inductance component is added to juxtaposition and a capacitance component is further added to a serial at a balanced signal terminal side (or to juxtaposition, a capacitance component). The method of taking adjustment so that the relation of the impedance of an unbalance-balance signal terminal may be differed about 2 times by adding a matching component for an inductance component to juxtaposition out of surface acoustic wave equipments, such as addition, has also been used.

[0020]

The measuring circuit which added [the frequency characteristics when taking adjustment so that the relation of the impedance of an unbalance-balance signal terminal may be differed about 2 times in the property of drawing 30] the external component for drawing 34 and an impedance characteristic (the range of 880MHz - 915MHz) to drawing 35 (a) and (b) is shown in drawing 36 . In addition, drawing 3434 , drawing 35 (a), and (b) also showed the property when you have no external component because of a comparison. Although it was possible to have made the relation of the impedance of an unbalance-balance signal terminal differ about 2 times by this approach as shown in drawing 3434 , drawing 35 (a), and (b), there was a problem of becoming the evil of the miniaturization accompanying the increment in the component part by addition of an external component and it.

[0021]

Such a problem arises similarly, not only when making the relation of the impedance of an unbalance-balance signal terminal differ about 2 times, but when making the relation of the impedance of an unbalance-balance signal terminal differ about 3 times.

[0022]

[Means for Solving the Problem]

In the surface acoustic wave equipment equipped with two or more IDT(s) so that

it might have balanced - unbalance conversion function in order that the surface acoustic wave equipment of this invention might cancel the above-mentioned technical problem When it considers as the electrode **** number N2 of IDT by which the electrode **** number of IDT connected to the balanced signal terminal side was connected to the N1 and unbalance signal terminal side, Ratios N2/N1 are 50 - 70%, and it is considering as the description that said electrode decussation width of face (W) of IDT is set as the range of 43lambda-58lambda to the wavelength lambda of a surface acoustic wave.

[0023]

According to the above-mentioned configuration, by the above-mentioned setup, addition of a new external component etc. is excluded and relation of the impedance of an unbalance signal terminal and a balanced signal terminal is made to 1:2 thru/or 1:3 by the simple configuration.

[0024]

It is desirable that the pitch of the electrode finger with which IDT which adjoins a reflector among said IDT(s), and said reflector adjoin each other with the above-mentioned surface acoustic wave equipment in the part which adjoins each other mutually is 0.46lambdar-0.54lambdar to electrode period lambdar of said reflector.

[0025]

In the above-mentioned surface acoustic wave equipment, the frequency fidt decided by said electrode period of IDT may be set up in =(fref/fidt)0.993-1.008 to the frequency fref decided by the electrode period of said reflector.

[0026]

The 1st surface acoustic wave filter which has three or more IDT(s) [odd] formed along the propagation direction of a surface acoustic wave on the piezo-electric substrate with the above-mentioned surface acoustic wave equipment, It has the 2nd surface acoustic wave filter with which the phases of an output signal differ about 180 degrees to an input signal. You may have balanced - unbalance conversion function by using as a balanced signal terminal the

terminal which connected to the unbalance signal terminal and the serial the terminal which connected electrically to juxtaposition the terminal in the said 1st and 2nd surface acoustic wave filter which is one side, respectively, connected another side to the serial electrically, and was connected to said juxtaposition.

[0027]

In the above-mentioned surface acoustic wave equipment, when setting the number of IDT(s) to k, IDT of [(k-1) /2] individual may be connected to an unbalance signal terminal, and IDT of {[(k-1) /2]+1} individual may be connected to the balanced signal terminal, respectively.

[0028]

In one surface acoustic wave filter formed along the propagation direction of a surface acoustic wave with the above-mentioned surface acoustic wave equipment on the piezo-electric substrate It may have the 1st terminal with which the difference of the phase of an output signal becomes about 0 times to an input signal, and the 2nd terminal with which the difference of the phase of an output signal becomes about 180 degrees to an input signal, and you may have balanced - unbalance conversion function by connecting the 1st terminal of the above, and the 2nd terminal of each other to a serial.

[0029]

In the above-mentioned surface acoustic wave equipment, two or more IDT(s) may be prepared in the vertical joint resonator mold filter which has three IDT(s).

[0030]

With the above-mentioned surface acoustic wave equipment, at least one surface acoustic wave resonator may be electrically connected to IDT connected to a balanced signal terminal side at least at the serial.

[0031]

According to the above-mentioned configuration, since the magnitude of attenuation outside a passband can be further enlarged by having connected electrically at least one surface acoustic wave resonator to IDT connected to a balanced signal terminal side at least at the serial, a filter shape can be improved.

[0032]
The inside of resonance mode [in / on the above-mentioned surface acoustic wave equipment and / each IDT], When the exciting frequency of standing wave resonance mode which has the peak of the intensity distribution of a surface acoustic wave for the exciting frequency in zero-order mode between f0 and IDT-IDT was set to fN, resonance frequency of a surface acoustic wave resonator is set to f1 and antiresonant frequency is set to f2, You may connect with the serial electrically so that at least one surface acoustic wave resonator may turn into a terminal connected to IDT located in both ends at least with $f1<f0<fN<f2$, respectively.
[0033]
It is desirable to be set up with the above-mentioned surface acoustic wave equipment, so that the relation to 1:2 thru/or 1:3 of the impedance of an unbalance signal terminal and a balanced signal terminal may become.
[0034]
The communication device of this invention is characterized by having surface acoustic wave equipment given in above any they are, in order to cancel the aforementioned technical problem.
[0035]
According to the above-mentioned configuration, the used surface acoustic wave equipment has the property as for which could be equipped with the balanced type-unbalance conversion function with the filtering function, and relation of the impedance of an unbalance signal terminal and a balanced signal terminal was moreover made to 1:2 thru/or 1:3 and which was excellent in the magnitude of attenuation outside a passband. Therefore, the communication device of this invention which has the above-mentioned surface acoustic wave equipment can be improving the transmission characteristic.
[0036]
[Embodiment of the Invention]
The communication device equipped with the surface acoustic wave equipment

of each gestalt of operation and it concerning this invention is explained to drawing 1 thru/or drawing 27 R> 7, and a list below based on drawing 37 thru/or drawing 42 .

[0037]

The terminal impedance by the side of the unbalance signal terminal 313 is [the terminal impedance by the side of 50 ohms, each balanced signal terminal 314, and 315] 100ohms, and the first gestalt of the operation in the surface acoustic wave equipment concerning this invention is designed as a filter for EGSM transmission of a configuration of that the impedance of an unbalance-balance signal terminal becomes twice [about], as shown in drawing 1 . In addition, a frequency range required for the passband of the filter for EGSM transmission is 880MHz - 915MHz, and center frequency is 897.5MHz.

[0038]

the first gestalt of operation -- 40 **5-degreeYcutX propagation LiTaO3 from -- the surface acoustic wave filter is formed with aluminum electrode on the becoming piezo-electric substrate 300. if the configuration of the first gestalt of operation is explained to a detail -- right and left (IDT303 is inserted along the propagation direction of a surface acoustic wave -- as) of IDT303 -- every -- IDT 304 and 305 is arranged, and the vertical joint resonator mold surface acoustic element 301 in which each reflectors 306 and 307 were formed is formed so that these IDT(s) 304, 303, and 305 may be further put from right and left.

[0039]

Similarly, the vertical joint resonator mold surface acoustic element 302 in which reflectors 311 and 312 were formed is formed so that the phase relation of an output signal may differ 180 degrees to a surface acoustic element 301, so that each IDT 309 and 310 may be arranged at right and left of IDT308 and these IDT(s) 309, 308, and 310 may be put.

[0040]

Here, IDT 303, 304, 305, 308, 309, and 310 is smaller than the part of everything [pitch / of the electrode finger of a part] but IDT in part (** pitch electrode finger).

Incidentally, by drawing 1 , in order to make drawing brief, the number of an electrode finger is shown few. An unbalance signal terminal, a terminal 314, and the terminal 315 of a terminal 313 are balanced signal terminals.

[0041]

Next, when wavelength decided by the pitch of W [mum] and IDT in the decussation width of face of each surface acoustic elements 301 and 302 is set to lambdaI [mum] in the configuration of drawing 1 , When the electrode finger total of IDT 304, 305, 309, and 310 by which wavelength ratio W/lambdaI of decussation width of face and the electrode finger total of IDT 303 and 308 connected to the unbalance signal terminal 313 were connected to N1 and the balanced signal terminals 314 and 315 is set to N2, The ratio of the electrode finger connected to the unbalance signal terminal 313 and each balanced signal terminals 314 and 315 is set to N2/N1 [%] (it considers as an electrode characteristic ratio hereafter).

[0042]

Drawing 2 and drawing 3 set the X-axis as decussation width-of-face W/lambda I, and VSWR (Voltage Standing Wave Ratio) when seeing by the dependency and two or more electrode characteristic ratios N2/N1 of fractional band width is shown, respectively. In the case of the filter for EGSM transmission, consideration of a temperature-change margin and a manufacture tolerance margin needs the bandwidth of 44MHz to need pass band width being 35MHz. That is, as for fractional band width, it is desirable that they are 44MHz / 892.5MHz = 4.9% or more.

[0043]

Moreover, as for the impedance in a passband, it is desirable that it is close to a terminal impedance as much as possible. It is the characteristic impedance of ZL and surface acoustic wave equipment about a terminal impedance Z0 If it carries out, it will be expressed with reflection coefficient gamma=(ZL-Z0)/(ZL+Z0), and VSWR will become (1+|gamma|)/(1-|gamma|). Therefore, VSWR was used as an index of the gap from the terminal impedance of surface acoustic wave

equipment. Even if it considers VSWR from the demand level from a commercial scene, it needs to be set to at most 2.0 (2.0 or less [that is,]).

[0044]

In drawing 2 , the electrode characteristic ratios N2/N1 are above 50%, or the time of the decussation width of face W being more than 43lambdaI at 50% fills 4.9% or more of fractional band width called for. Here, the electrode characteristic ratios N2/N1 can draw that more than 43lambdaI is desirable by the decussation width of face W 50% or more.

[0045]

Next, in drawing 3 , since the above-mentioned decussation width of face W calls it more than 43lambdaI preferably [since the above-mentioned electrode characteristic ratios N2/N1 call it 50% or more to fill less than / VSWR=2 / which is called for / below 58lambdaI] as for decussation width of face, by the electrode characteristic ratios N2/N1, it turns out that 70% or less is desirable.

[0046]

Therefore, as for the fractional band width demanded filling 4.9% or more, and VSWR filling two or less, the electrode characteristic ratios N2/N1 of 50% or more, 70% or less, and decussation width of face are more than 43lambdaI at the time below 58lambdaI.

[0047]

Next, the X-axis is set as the electrode characteristic ratios N2/N1, and VSWR when seeing at intervals of two or more IDT-reflectors [I-R gap (lambdar)] and the dependency of fractional band width are shown in drawing 4 and drawing 5 . At this time, decussation width-of-face W/lambda I is fixed to 50.5lambdaI. When drawing 4 is seen, the electrode characteristic ratios N2/N1 are at the time below IDT-reflector spacing 0.54lambdar, when wavelength it is decided in the pitch of a reflector that it will be that VSWR becomes 2.0 or less in 70% or less of range 50% or more is set to lambdar [mum]. Moreover, when drawing 5 is observed, it is that fractional band width becomes 4.9% or more at the time more than IDT-reflector spacing 0.46lambdar.

[0048]
From the above thing, the electrode characteristic ratios N2/N1 can say that it is desirable that it is below 0.54lambdar more than 0.46lambdar as for IDT-reflector spacing in 50% or more and 70% or less of range.
[0049]
Moreover, when the frequency decided by the acoustic velocity of fref and IDT and the pitch in the frequency decided by the acoustic velocity of a reflector and the pitch is set to fidt, the ratio (henceforth a frequency ratio) of the frequency of a reflector to the frequency of IDT is made into fref/fidt. The X-axis is set as IDT-reflector spacing at drawing 6 and drawing 7 B, and it is shown in VSWR when seeing by two or more frequency-ratio fref/fidt, and the dependency of fractional band width, respectively. At this time, decussation width-of-face W/lambda I is fixing 50.5lambdaI and the electrode characteristic ratios N2/N1 to about 60%.
[0050]
In order for VSWR to tend to become large and for IDT-reflector spacing to satisfy 2.0 or less VSWR in the range below 0.54lambdar more than 0.46lambdar as IDT-reflector spacing becomes large if drawing 6 is observed, it can be said that it is desirable that it is 0.993 or more and 1.008 or less as for frequency-ratio fref/fidt.
[0051]
Next, when drawing 7 is observed, fractional band width is in the inclination to change to parabolic [convex], to IDT-reflector spacing. Since IDT-reflector spacing is in the field except [its] where frequency-ratio fref/fidt is most stabilized [in / more than 0.46lambdar / the range below 0.54lambdar] in the 0.993 or more and 1.003 or less range, and inclination is large, change of the property over IDT-reflector spacing becomes unstable greatly. It can be said that it is more desirable than the above thing that it is 0.993 or more and 1.003 or less range as for frequency-ratio fref/fidt.
[0052]
An impedance characteristic is shown in drawing 9 (a) and drawing 9 (b), and a

reflection property (VSWR) is shown for the frequency characteristics when designing with the configuration of the first gestalt of this operation using the above-mentioned parameter of the optimal within the limits in drawing 8 at drawing 10 , respectively. In addition, an unbalance terminal side is [a balanced 50 ohm and terminal side] 100ohms, and the normalized impedance at this time has relation of 1:2.

[0053]

Moreover, the detailed design of each surface acoustic elements 301 and 302 of a vertical joint resonator mold when the property of drawing 8 thru/or drawing 10 is acquired is shown below. In addition, wavelength of lambdaI and a reflector is set to lambdaR for the wavelength decided by the pitch of lambdai and other electrode fingers, respectively in the wavelength decided by below in the pitch of a ** pitch electrode finger, respectively.

- Decussation width of face of W:228 micrometers (51lambdaI)
- IDT number (order of 304, 303, and 305): -- (4)2929(4) / (3)35(3) (the same of the inside of a parenthesis is said also of the number of a ** pitch electrode finger, and 309, 308 and 310)
- 1:132 numbers N of the electrode finger connected to the balanced signal terminal
- 2:82 numbers N of the electrode finger connected to the unbalance signal terminal side (1= 62.1% of N2/N)
- 2:82 numbers N of the electrode finger connected to the unbalance signal terminal side (1= 62.1% of N2/N)
- Reflector number : 90
- Reflector frequency fref/(IDT frequency fidt):0.998
- IDT-reflector spacing : 0.50lambdaR

When the f= 880MHz point was plotted to the impedance characteristic which sets to Y and is shown in drawing 9 (a) and drawing 9 (b), as for the impedance of a passband, S11 lowered X and the f= 915MHz point for it a little from 50ohms by 43ohm-46ohm, and adjustment can be but taken mostly in normalized

impedance. Moreover, although S22 is the appearance from which the impedance of a X-Y point shifted more highly a little to the point having consistency, it can be said to be have taken adjustment in normalized impedance mostly. By this, the relation of the impedance of an unbalance signal terminal and a balanced signal terminal will be set to about 1:2.

[0054]

Moreover, in the structure of drawing 1 , an impedance characteristic is shown in drawing 38 (a) and drawing 38 (b), and a reflection property (VSWR) is shown for frequency characteristics when a balanced 50-ohm and signal terminal side sets normalized impedance to 150 ohms and an unbalance signal terminal side considers it as the relation of 1:3 on the conditions from which the property of drawing 8 thru/or drawing 10 was acquired in drawing 37 at drawing 39 , respectively.

[0055]

Although the impedance of a X-Y point is shifted a little lowness to the point having consistency if its attention is paid to the impedance of S22, VSWR is settled less than in 2.0 and has taken adjustment by normalized impedance mostly. If this designs using the above mentioned parameter of the optimal within the limits, it can also be said that it is possible to set relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.

[0056]

The detailed design of each surface acoustic elements 301 and 302 at this time is shown below. In addition, wavelength of lambdaI and a reflector is set to lambdaR for the wavelength decided by the pitch of lambdai and other electrode fingers, respectively in the wavelength decided by below in the pitch of a ** pitch electrode finger, respectively.

- Decussation width of face of W:228 micrometers (51lambdaI)
- IDT number (order of 304, 303, and 305): -- (4)2929(4) / (3)35(3) (the same of the inside of a parenthesis is said also of the number of a ** pitch electrode finger, and 309, 308 and 310)

- 1:132 numbers N of the electrode finger connected to the balanced signal terminal
- 2:82 numbers N of the electrode finger connected to the unbalance signal terminal side (1= 62.1% of N2/N)
- Reflector number : 90
- Reflector frequency fref/(IDT frequency fidt):0.998
- IDT-reflector spacing : 0.50lambdaR

thus, in order to acquire the property that the relation to 1:2 thru/or 1:3 of the impedance of an unbalance signal terminal and a balanced signal terminal becomes When the number of IDT is made into n pieces, connect each to juxtaposition electrically in /2 piece IDT in the 1st and 2nd surface acoustic element (n-1), and it considers as an unbalance signal terminal. A configuration like drawing 1 which used as the balanced signal terminal the terminal which connected to the serial electrically at IDT of {[(n-1) /2]+1} individual, and was connected to the serial the logarithm of the I/O IDT in one surface acoustic element -- it can be said that it is more desirable from the ability to maintain at a near condition by the case where relation is the usual design.

[0057]

In addition, although the example of the vertical joint resonator mold which used three IDT(s) as a surface acoustic element was given above, as shown in drawing 11 , the surface acoustic element of the vertical joint resonator mold using five IDT(s) may be used, respectively. Moreover, although two surface acoustic elements are used with the first gestalt of operation, the same thing can be said also in the surface acoustic element which has balanced - unbalance conversion function with one surface acoustic wave filter like drawing 23 or drawing 24 .

[0058]

In the surface acoustic wave equipment which has balanced - unbalance conversion function with the first gestalt of operation as explained above When it considers as the electrode **** number N2 of IDT by which the electrode ****

number of IDT connected to the balanced signal terminal side was connected to the N1 and unbalance signal terminal side, Still more desirably with ratios N2/N1 being 50% - 70%, and said electrode decussation width of face (W) of IDT constituting in the range of 43lambda-58lambda to the wavelength lambda of a surface acoustic wave IDT-reflector spacing is below 0.54lambdar or that frequency-ratio fref/fidt constitutes in the 0.993 or more and 1.003 or less range more than 0.46lambdar. The surface acoustic wave equipment with which the relation to 1:2 thru/or 1:3 of the impedance of an unbalance signal terminal and a balanced signal terminal becomes is obtained.

[0059]

Below, the surface acoustic wave equipment concerning the second gestalt of operation is explained. With the second gestalt of operation, about the member which has the same function as the first gestalt of operation shown in drawing 1 , as shown in drawing 12 , the same member number was given and those explanation was omitted.

[0060]

In the configuration of the second gestalt of operation, as shown in drawing 12 , the surface acoustic wave resonator 431 is connected to the serial in [428] that IDT304 and IDT305 in a surface acoustic element 301 are connected to juxtaposition.

[0061]

Similarly, the surface acoustic wave resonator 432 is connected to the serial at the point 429 also about the surface acoustic element 302. It is formed by arranging reflectors 434 (437) and 435 (438) so that the surface acoustic wave resonator 431 (432) may arrange IDT433 (436) in accordance with a propagation path and this IDT may be put. In addition, the detailed design of the surface acoustic wave resonators 431 and 432 is as follows when wavelength decided by the pitch of lambdati and a reflector in the wavelength decided by the pitch of IDT of a surface acoustic wave resonator, respectively is set to lambdatr, respectively.

- Decussation width of face : 100 micrometers

- IDT number : 161
- Reflector number : ten
- IDT-reflector spacing : 0.50lambdatr
- IDTduty:0.70
- Reflector duty:0.70
- IDT frequency fti/(reflector frequency ftr) =1.0

An impedance characteristic is shown in drawing 14 (a) and drawing 14 (b), and a reflection property (VSWR) is shown for the frequency characteristics in the configuration of the second gestalt of operation in drawing 13 at drawing 15 , respectively. In addition, an unbalance terminal side is [a balanced 50 ohm and terminal side] 100ohms, and the normalized impedance at this time has relation of 1:2. When the f= 880MHz point is plotted to an impedance characteristic, using X and the f= 915MHz point as Y, as it is shown in drawing 14 (a), drawing 14 (b), and drawing 15 , the impedance of a passband can be said to be that S11 and S22 have taken adjustment in normalized impedance. By this, the relation of the impedance of an unbalance signal terminal and a balanced signal terminal will be set to about 1:2.

[0062]

Moreover, in the structure of drawing 12 , an impedance characteristic is shown in drawing 41 (a) and drawing 41 (b), and a reflection property (VSWR) is shown for frequency characteristics when a balanced 50-ohm and signal terminal side sets normalized impedance to 150 ohms and an unbalance signal terminal side considers it as the relation of 1:3 on the conditions from which the property of drawing 13 thru/or drawing 15 was acquired in drawing 40 at drawing 42 , respectively.

[0063]

As shown in drawing 40 thru/or drawing 42 , even when normalized impedance by the side of a balanced signal terminal is set to 150 ohms, S11 and S22 have taken adjustment comparatively. If this designs with the configuration of the second gestalt of this operation, it can also be said that it is possible to set

relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.

[0064]

The detailed design of each surface acoustic wave resonators 431 and 432 at this time is as follows when wavelength decided by the pitch of lambdati and a reflector in the wavelength decided by the pitch of IDT of a surface acoustic wave resonator, respectively is set to lambdatr, respectively.

- Decussation width of face : 100 micrometers
- IDT number : 161
- Reflector number : ten
- IDT-reflector spacing : 0.50lambdatr
- IDTduty:0.70
- Reflector duty:0.70
- IDT frequency fti/(reflector frequency ftr) =1.0

Next, why the effectiveness of the second gestalt of operation was acquired is explained. First, the frequency-impedance characteristic of the surface acoustic wave resonators 431 and 432 is shown in drawing 16 . In drawing 16 , if the point which becomes resonance frequency f1 and the maximum about the frequency from which an impedance becomes the minimum is carried out antiresonant frequency f2, each surface acoustic wave resonators 431 and 432 serve as f1=895.5MHz and f2=928.5MHz. When a surface acoustic wave resonator is added to a serial, it works to inductivity and the impedance of the added side commits the frequency domain from resonance frequency f1 to antiresonant frequency f2 to capacitive in the other field.

[0065]

Moreover, in the surface acoustic element of the vertical joint resonator mold of 3IDT molds like the gestalt of this operation, in order to form a passband, as shown in drawing 17 and drawing 18 , three resonance modes are used. Drawing 17 R> 7 is the frequency characteristics which removed and measured the impedance intentionally in order to make intelligible resonance mode of the

property only in the surface acoustic element 301 and surface acoustic element 402 in a configuration of the second gestalt of operation. Moreover, the intensity distribution of each active current are shown in drawing 18 .

[0066]

The response with the lowest frequency which hits at an A point is resonance mode which is called the secondary mode and has two knots in active current distribution. The response of the center of a band which hits at a B point is the mode which is called zero-order mode and does not have a knot in active current intensity distribution. The response with the highest frequency of C point is standing wave resonance mode (it considers as the mode by the side of a high region hereafter) which has the peak of the intensity distribution of a surface acoustic wave in the IDT-IDT spacing section.

[0067]

In the case of the second gestalt of operation, a secondary mode frequency is [the mode by the side of 901MHz and a high region of 876MHz and a zero-order mode frequency] 922.5MHz. That is, the mode by the side of the zero-order mode frequency of a surface acoustic element 401 and a surface acoustic element 402 and a high region will be located between the resonance frequency f1 of the surface acoustic wave resonators 431 and 432, and antiresonant frequency f2.

[0068]

Here, with the configuration of the second gestalt of operation, from the condition of only each surface acoustic elements 401 and 402, change of the impedance characteristic when adding the surface acoustic wave resonators 431 and 432 is divided into a frequency region, and is seen. Drawing 19 (a) and drawing 19 (b) show change of an impedance whose drawing 20 (a) and drawing 20 (b) last change of the impedance characteristic which lasts to 895.5MHz (resonance frequency f1) from 880MHz from 895.5MHz (resonance frequency f1) to 928.5MHz (antiresonant frequency f2).

[0069]

In order that a surface acoustic wave resonator may work to capacitive if drawing 19 and drawing 20 are observed, and it applies to 880MHz - 895.5MHz by the side of passband low-pass, the impedance of S22 is shifted to capacitive. If it applies to 928.5MHz from 895.5MHz which hits a passband quantity region side, in order that a surface acoustic wave resonator may work to inductivity on the other hand, the impedance of S22 becomes the appearance which occurs on a real axis, and an adjustment condition becomes good. that is, the thing inserted in the frequency band covered over zero-order [for forming a passband quantity region side], and high region mode so that a surface acoustic wave resonator may work to inductivity -- the relation of the impedance of I/O -- about 1:2 thru/or 1:3 -- becoming -- and the outside of a passband -- setting -- high -- a property [****] can be acquired.

[0070]

Although it connects, respectively and each surface acoustic wave resonators 431 and 432 are constituted from a gestalt of this operation only in the balanced signal terminal side, two or more surface acoustic wave resonators may be connected to both by the side of a balanced signal and an unbalance signal every again. Another example in the gestalt of this operation is shown in drawing 21 and drawing 22 , respectively.

[0071]

Moreover, although two surface acoustic wave filters are used with the second gestalt of operation, the same thing can be said also in the surface acoustic element which has balanced - unbalance conversion function with one surface acoustic wave filter like drawing 25 and drawing 26 .

[0072]

In the surface acoustic wave equipment which has balanced - unbalance conversion function with the second gestalt of operation as explained above When it considers as the electrode **** number N2 of IDT by which the electrode **** number of IDT connected to the balanced signal terminal side was connected to the N1 and unbalance signal terminal side, With ratios N2/N1 being

50 - 70%, and said electrode decussation width of face (W) of IDT constituting in the range of 43lambdaI - 58lambdaI to wavelength lambdaI of a surface acoustic wave Still more desirably IDT-reflector spacing more than 0.46lambdar Below 0.54lambdar By or the thing for which at least one surface acoustic wave resonator will be electrically connected to IDT connected to the balanced side edge child at a serial if frequency-ratio fref/fidt constitutes in the or more 0.993 1.003 or less range and there is [little] The surface acoustic wave equipment of the property which the relation to 1:2 thru/or 1:3 of the impedance of an unbalance signal terminal and a balanced signal terminal became, and was excellent in the magnitude of attenuation outside a passband is obtained.

[0073]

Next, the communication device carrying the surface acoustic wave equipment of a publication is explained to each gestalt of the above-mentioned implementation based on drawing 27 . As a receiver side (Rx side) which receives, the above-mentioned communication device 600 is equipped with an antenna 601, the antenna common section / RFTop filter 602, amplifier 603, Rx interstage filter 604, a mixer 605, the 1stIF filter 606, a mixer 607, the 2ndIF filter 608, the 1st+2nd local synthesizer 611, TCXO (temperature compensated crystal oscillator (temperature-compensated crystal oscillator))612, a divider 613, and the local filter 614, and is constituted.

[0074]

As double lines showed, in order to secure balance nature from Rx interstage filter 604 to drawing 27 to a mixer 605, transmitting by each balanced signal is desirable.

[0075]

Moreover, as a transceiver side (Tx side) which transmits, it has the TxIF filter 621, a mixer 622, Tx interstage filter 623, amplifier 624, a coupler 625, an isolator 626, and APC (automatic power control)627 (APC), and the above-mentioned communication device 600 is constituted while sharing the above-mentioned antenna 601, and the above-mentioned above-mentioned antenna common

section / RFTop filter 602.

[0076]

And surface acoustic wave equipment given in the gestalt of this operation mentioned above can use for the above-mentioned Rx interstage filter 604, the 1stIF filter 606, the TxIF filter 621, and Tx interstage filter 623 suitably.

[0077]

The surface acoustic wave equipment concerning this invention has the property as for which could be equipped with the balanced type-unbalance conversion function with the filtering function, and relation of the impedance of an unbalance signal terminal and a balanced signal terminal was moreover made to 1:2 thru/or 1:3 and which was excellent in the magnitude of attenuation outside a passband. Therefore, the communication device of this invention which has the above-mentioned surface acoustic wave equipment can be improving the transmission characteristic.

[0078]

[Effect of the Invention]

When the surface acoustic wave equipment of this invention is made into the electrode **** number N2 of IDT by which the electrode **** number of IDT connected to the balanced signal terminal side was connected as mentioned above to the N1 and unbalance signal terminal side, With ratios N2/N1 being 50 - 70%, and said electrode decussation width of face (W) of IDT constituting in the range of 43lambda-58lambda to the wavelength lambda of a surface acoustic wave IDT-reflector spacing is that below 0.54lambdar or frequency-ratio fref/fidt constitutes in the or more 0.993 1.003 or less range more than 0.46lambdar still more desirably. The surface acoustic wave equipment as for which relation of the impedance of an unbalance signal terminal and a balanced signal terminal is made to 1:2 thru/or 1:3 is obtained.

[0079]

Furthermore, the surface acoustic wave equipment of the property as for which relation of the impedance of an unbalance signal terminal and a balanced signal

terminal was made to 1:2 thru/or 1:3 and which excelled [connect / one surface acoustic wave resonator / if few / to IDT connected to the balanced side edge child / at a serial / electrically] in the magnitude of attenuation out of band is obtained.

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram of the surface acoustic wave equipment in the first gestalt of operation concerning this invention.

[Drawing 2] It is the graph which shows the dependency of the fractional band width when setting the X-axis as decussation width-of-face W/lambda I with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or more electrode characteristic ratios N2/N1.

[Drawing 3] It is the graph which shows the dependency of VSWR when setting the X-axis as decussation width-of-face W/lambda I with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or more electrode characteristic ratios N2/N1.

[Drawing 4] It is the graph which shows the dependency of VSWR when setting the X-axis as the electrode characteristic ratios N2/N1 with the configuration of the first gestalt of the above-mentioned implementation, and seeing at intervals of two or more IDT-reflectors.

[Drawing 5] It is the graph which shows the dependency of the fractional band width when setting the X-axis as the electrode characteristic ratios N2/N1 with the configuration of the first gestalt of the above-mentioned implementation, and seeing at intervals of two or more IDT-reflectors.

[Drawing 6] It is the graph which shows the dependency of VSWR when setting the X-axis as IDT-reflector spacing with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or more frequency-ratio fref/fidt.

[Drawing 7] It is the graph which shows the dependency of the fractional band width when setting the X-axis as IDT-reflector spacing with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or

more frequency-ratio fref/fidt.

[Drawing 8] It is the graph which shows the typical frequency characteristics in the configuration of the first gestalt of the above-mentioned implementation.

[Drawing 9] It is the graph which shows the typical impedance characteristic in the configuration of the first gestalt of the above-mentioned implementation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 10] It is the graph which shows the typical reflective (VSWR) property in the configuration of the first gestalt of the above-mentioned implementation.

[Drawing 11] It is the outline block diagram showing the surface acoustic wave equipment of another modification in the first gestalt of the above-mentioned implementation.

[Drawing 12] It is the outline block diagram of the surface acoustic wave equipment in the second gestalt of operation concerning this invention.

[Drawing 13] It is the graph which shows the typical frequency characteristics in the configuration of the second gestalt of the above-mentioned implementation.

[Drawing 14] It is the graph which shows the typical impedance characteristic in the configuration of the second gestalt of the above-mentioned implementation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 15] It is the graph which shows the typical reflective (VSWR) property in the configuration of the second gestalt of the above-mentioned implementation.

[Drawing 16] It is the graph which shows the frequency-impedance characteristic of the surface acoustic wave resonator used for the surface acoustic wave equipment in the second gestalt of the above-mentioned implementation.

[Drawing 17] It is the graph which shows each resonance mode of the surface acoustic element used for the surface acoustic wave equipment in the second gestalt of the above-mentioned implementation.

[Drawing 18] It is the graph corresponding to the outline block diagram of IDT in (a) which shows active current distribution of each above-mentioned resonance

mode, and shows each resonance mode which made (b) corresponding to [arrangement / of Above IDT].

[Drawing 19] It is the graph which shows each impedance characteristic (a 880MHz - 895.5MHz side, low-pass side) at the time of the configuration (nothing [resonator]) which excluded the resonator from the configuration (********) of the second gestalt of the above-mentioned implementation, and the configuration of the second gestalt of operation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 20] It is the graph which shows each impedance characteristic (a 895.5MHz - 928.5MHz side, high region side) at the time of the configuration (nothing [resonator]) which excluded the resonator from the configuration (********) of the second gestalt of the above-mentioned implementation, and the configuration of the second gestalt of operation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 21] It is the outline block diagram of the surface acoustic wave equipment concerning another modification in the second gestalt of the above-mentioned implementation.

[Drawing 22] It is the outline block diagram of another example to the pan in the second gestalt of the above-mentioned implementation.

[Drawing 23] It is the outline block diagram of still more nearly another example of the first gestalt of said operation.

[Drawing 24] It is the outline block diagram of still more nearly another example of the first gestalt of the above-mentioned implementation.

[Drawing 25] It is the outline block diagram of still more nearly another example of the second gestalt of the above-mentioned implementation.

[Drawing 26] It is the outline block diagram of another example to the pan in the second gestalt of the above-mentioned implementation.

[Drawing 27] It is the circuit block diagram of the communication device of this invention.

[Drawing 28] It is the conventional outline block diagram of the surface acoustic

wave equipment corresponding to unbalance-balance I/O.
[Drawing 29] It is the graph which shows the frequency characteristics in the above-mentioned former (example of the property that ON appearance KAIMPI dances differ about 4 times).
[Drawing 30] It is the graph which shows the impedance characteristic in the above-mentioned former (example of the property that ON appearance KAIMPI dances differ about 4 times), and (a) is a time of normalized impedance being 200ohms for (b) when normalized impedance is 50ohms.
[Drawing 31] It is the outline block diagram of the surface acoustic wave equipment with which the impedances of I/O of everything but the former differ.
[Drawing 32] It is the graph which shows the frequency characteristics at the time only of one surface acoustic wave filter among the configurations of above-mentioned drawing 31 .
[Drawing 33] It is the graph which shows the frequency characteristics in the configuration of above-mentioned drawing 31 .
[Drawing 34] It is the graph which shows the conventional surface acoustic wave equipment (example of the property that I/O impedances differ about 2 times) of further others, and the frequency characteristics at the time of external component addition.
[Drawing 35] It is the graph which shows the impedance characteristic at the time of the above-mentioned former (example of the property that I/O impedances differ about 2 times), and external component addition, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.
[Drawing 36] In the above-mentioned former, it is a circuit diagram at the time of external component addition.
[Drawing 37] In the first gestalt of said operation, it is the graph which shows the frequency characteristics when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Drawing 38] In the first gestalt of said operation, it is the graph which shows the

impedance characteristic when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3, and (a) is a time of normalized impedance being 150ohms for (b) when normalized impedance is 50ohms.
[Drawing 39] In the first gestalt of said operation, it is the graph which shows the reflection property (VSWR) when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Drawing 40] In the second gestalt of said operation, it is the graph which shows the frequency characteristics when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Drawing 41] In the second gestalt of said operation, it is the graph which shows the impedance characteristic when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3, and (a) is a time of normalized impedance being 150ohms for (b) when normalized impedance is 50ohms.
[Drawing 42] In the second gestalt of said operation, it is the graph which shows the reflection property (VSWR) when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Description of Notations]
303, 304, 305, 308, 309, 310 IDT313 (comb mold polar zone) Unbalance signal terminal
314 314 Balanced signal terminal side

[Translation done.]

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram of the surface acoustic wave equipment in the first gestalt of operation concerning this invention.

[Drawing 2] It is the graph which shows the dependency of the fractional band width when setting the X-axis as decussation width-of-face W/lambda I with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or more electrode characteristic ratios N2/N1.

[Drawing 3] It is the graph which shows the dependency of VSWR when setting the X-axis as decussation width-of-face W/lambda I with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or more electrode characteristic ratios N2/N1.

[Drawing 4] It is the graph which shows the dependency of VSWR when setting the X-axis as the electrode characteristic ratios N2/N1 with the configuration of the first gestalt of the above-mentioned implementation, and seeing at intervals of two or more IDT-reflectors.

[Drawing 5] It is the graph which shows the dependency of the fractional band width when setting the X-axis as the electrode characteristic ratios N2/N1 with the configuration of the first gestalt of the above-mentioned implementation, and seeing at intervals of two or more IDT-reflectors.

[Drawing 6] It is the graph which shows the dependency of VSWR when setting the X-axis as IDT-reflector spacing with the configuration of the first gestalt of the above-mentioned implementation, and seeing by two or more frequency-ratio fref/fidt.

[Drawing 7] It is the graph which shows the dependency of the fractional band width when setting the X-axis as IDT-reflector spacing with the configuration of

the first gestalt of the above-mentioned implementation, and seeing by two or more frequency-ratio fref/fidt.

[Drawing 8] It is the graph which shows the typical frequency characteristics in the configuration of the first gestalt of the above-mentioned implementation.

[Drawing 9] It is the graph which shows the typical impedance characteristic in the configuration of the first gestalt of the above-mentioned implementation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 10] It is the graph which shows the typical reflective (VSWR) property in the configuration of the first gestalt of the above-mentioned implementation.

[Drawing 11] It is the outline block diagram showing the surface acoustic wave equipment of another modification in the first gestalt of the above-mentioned implementation.

[Drawing 12] It is the outline block diagram of the surface acoustic wave equipment in the second gestalt of operation concerning this invention.

[Drawing 13] It is the graph which shows the typical frequency characteristics in the configuration of the second gestalt of the above-mentioned implementation.

[Drawing 14] It is the graph which shows the typical impedance characteristic in the configuration of the second gestalt of the above-mentioned implementation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 15] It is the graph which shows the typical reflective (VSWR) property in the configuration of the second gestalt of the above-mentioned implementation.

[Drawing 16] It is the graph which shows the frequency-impedance characteristic of the surface acoustic wave resonator used for the surface acoustic wave equipment in the second gestalt of the above-mentioned implementation.

[Drawing 17] It is the graph which shows each resonance mode of the surface acoustic element used for the surface acoustic wave equipment in the second gestalt of the above-mentioned implementation.

[Drawing 18] It is the graph corresponding to the outline block diagram of IDT in

(a) which shows active current distribution of each above-mentioned resonance mode, and shows each resonance mode which made (b) corresponding to [arrangement / of Above IDT].

[Drawing 19] It is the graph which shows each impedance characteristic (a 880MHz - 895.5MHz side, low-pass side) at the time of the configuration (nothing [resonator]) which excluded the resonator from the configuration (********) of the second gestalt of the above-mentioned implementation, and the configuration of the second gestalt of operation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 20] It is the graph which shows each impedance characteristic (a 895.5MHz - 928.5MHz side, high region side) at the time of the configuration (nothing [resonator]) which excluded the resonator from the configuration (********) of the second gestalt of the above-mentioned implementation, and the configuration of the second gestalt of operation, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.

[Drawing 21] It is the outline block diagram of the surface acoustic wave equipment concerning another modification in the second gestalt of the above-mentioned implementation.

[Drawing 22] It is the outline block diagram of another example to the pan in the second gestalt of the above-mentioned implementation.

[Drawing 23] It is the outline block diagram of still more nearly another example of the first gestalt of said operation.

[Drawing 24] It is the outline block diagram of still more nearly another example of the first gestalt of the above-mentioned implementation.

[Drawing 25] It is the outline block diagram of still more nearly another example of the second gestalt of the above-mentioned implementation.

[Drawing 26] It is the outline block diagram of another example to the pan in the second gestalt of the above-mentioned implementation.

[Drawing 27] It is the circuit block diagram of the communication device of this invention.

[Drawing 28] It is the conventional outline block diagram of the surface acoustic wave equipment corresponding to unbalance-balance I/O.
[Drawing 29] It is the graph which shows the frequency characteristics in the above-mentioned former (example of the property that ON appearance KAIMPI dances differ about 4 times).
[Drawing 30] It is the graph which shows the impedance characteristic in the above-mentioned former (example of the property that ON appearance KAIMPI dances differ about 4 times), and (a) is a time of normalized impedance being 200ohms for (b) when normalized impedance is 50ohms.
[Drawing 31] It is the outline block diagram of the surface acoustic wave equipment with which the impedances of I/O of everything but the former differ.
[Drawing 32] It is the graph which shows the frequency characteristics at the time only of one surface acoustic wave filter among the configurations of above-mentioned drawing 31 .
[Drawing 33] It is the graph which shows the frequency characteristics in the configuration of above-mentioned drawing 31 .
[Drawing 34] It is the graph which shows the conventional surface acoustic wave equipment (example of the property that I/O impedances differ about 2 times) of further others, and the frequency characteristics at the time of external component addition.
[Drawing 35] It is the graph which shows the impedance characteristic at the time of the above-mentioned former (example of the property that I/O impedances differ about 2 times), and external component addition, and (a) is a time of normalized impedance being 100ohms for (b) when normalized impedance is 50ohms.
[Drawing 36] In the above-mentioned former, it is a circuit diagram at the time of external component addition.
[Drawing 37] In the first gestalt of said operation, it is the graph which shows the frequency characteristics when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.

[Drawing 38] In the first gestalt of said operation, it is the graph which shows the impedance characteristic when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3, and (a) is a time of normalized impedance being 150ohms for (b) when normalized impedance is 50ohms.
[Drawing 39] In the first gestalt of said operation, it is the graph which shows the reflection property (VSWR) when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Drawing 40] In the second gestalt of said operation, it is the graph which shows the frequency characteristics when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Drawing 41] In the second gestalt of said operation, it is the graph which shows the impedance characteristic when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3, and (a) is a time of normalized impedance being 150ohms for (b) when normalized impedance is 50ohms.
[Drawing 42] In the second gestalt of said operation, it is the graph which shows the reflection property (VSWR) when setting relation of the impedance of an unbalance signal terminal and a balanced signal terminal to about 1:3.
[Description of Notations]
303, 304, 305, 308, 309, 310 IDT313 (comb mold polar zone) Unbalance signal terminal
314 314 Balanced signal terminal side

[Translation done.]

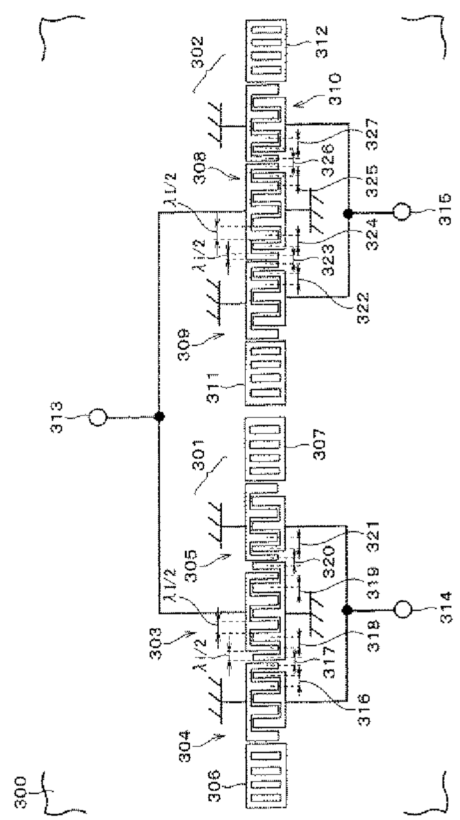
1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

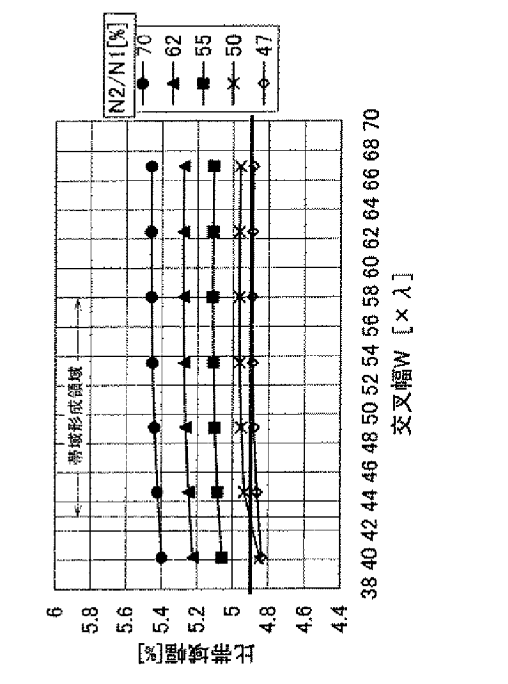
3.In the drawings, any words are not translated.

DRAWINGS

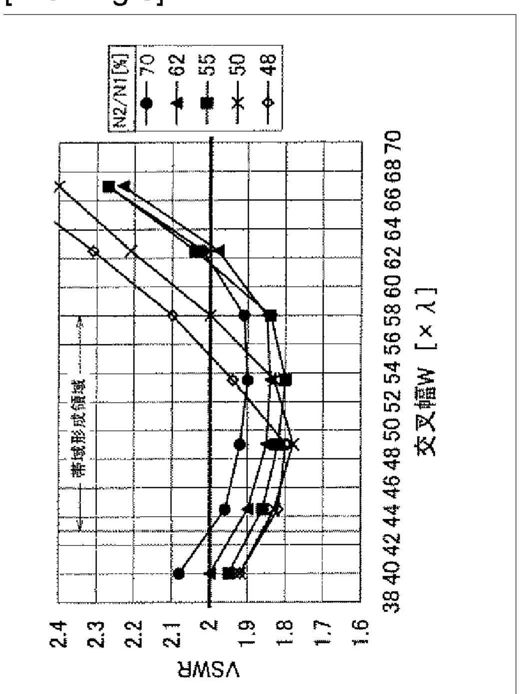
[Drawing 1]



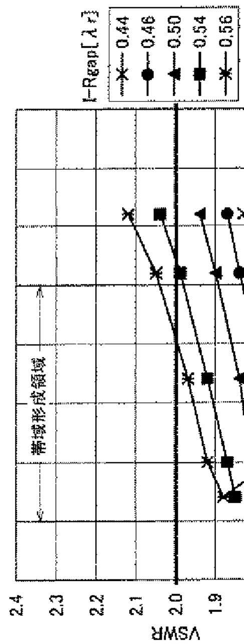
[Drawing 2]



[Drawing 3]

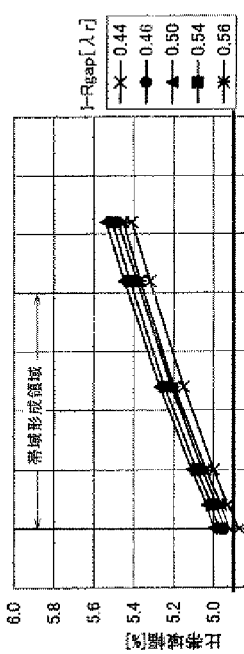


[Drawing 4]



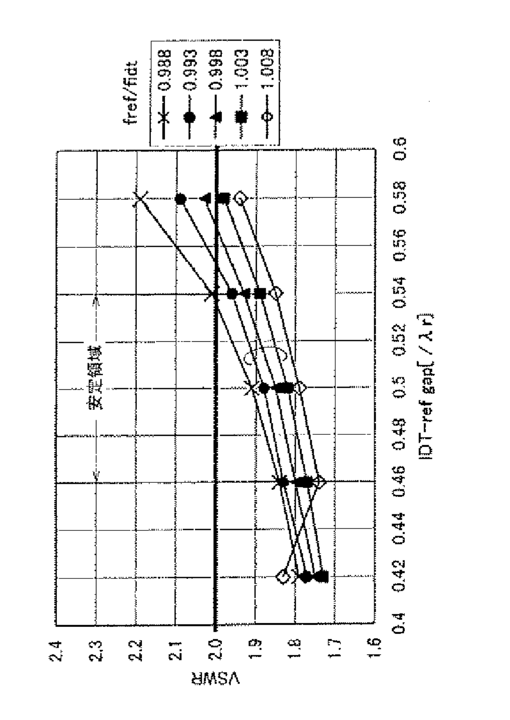
VSWR
N2/N1 [%]
帯域形成領域
I-Rgap[λr]
0.44
0.46
0.50
0.54
0.56

[Drawing 5]

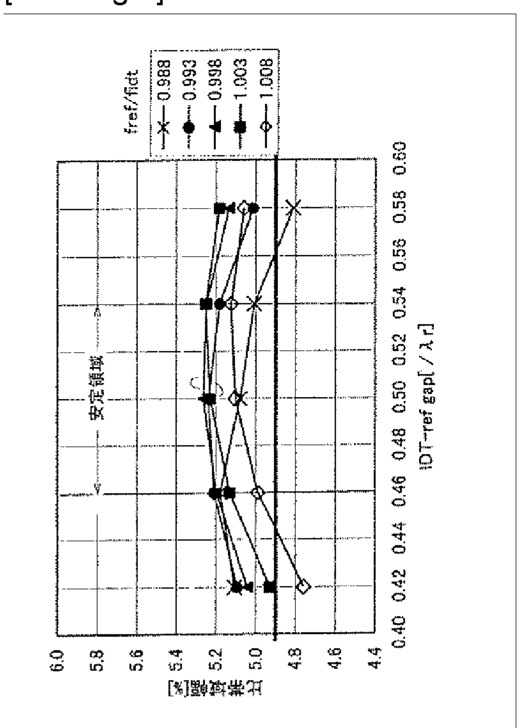


比帯域幅[%]
N2/N1 [%]
帯域形成領域
I-Rgap[λr]
0.44
0.46
0.50
0.54
0.56

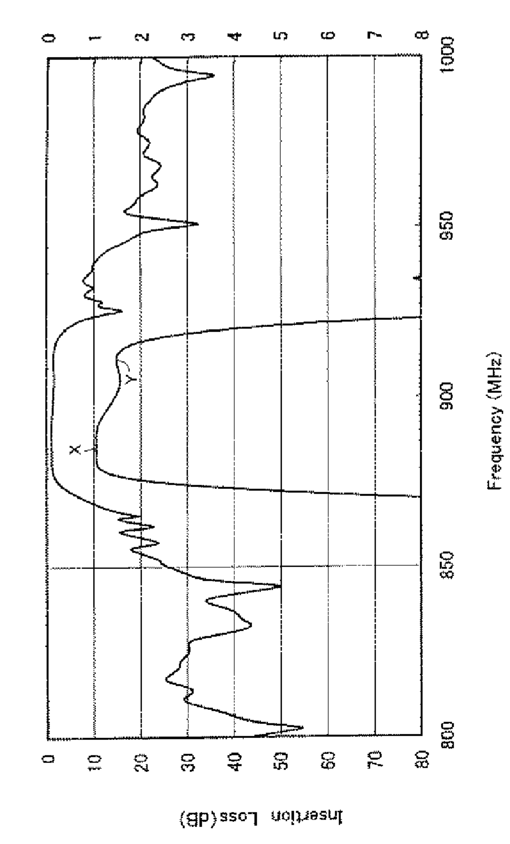
[Drawing 6]



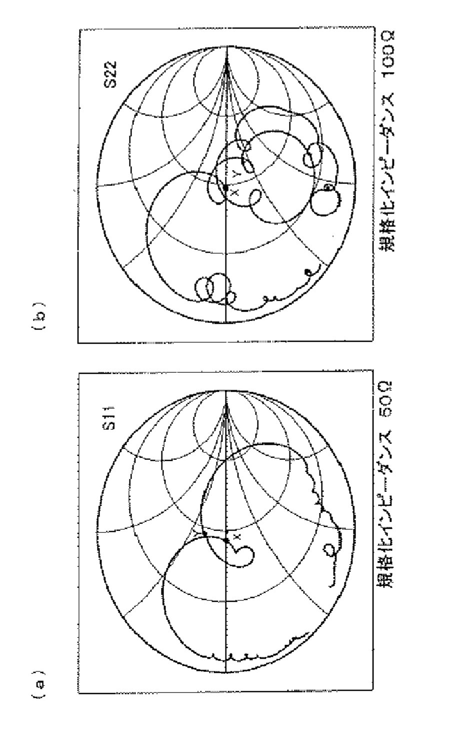
[Drawing 7]



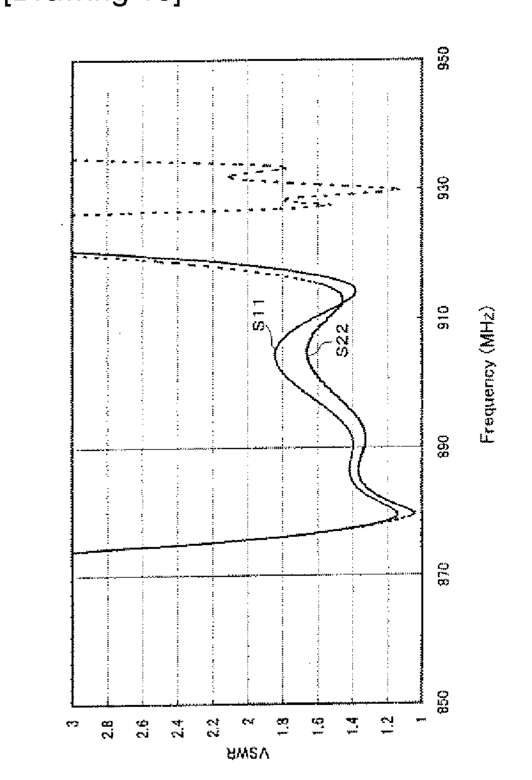
[Drawing 8]



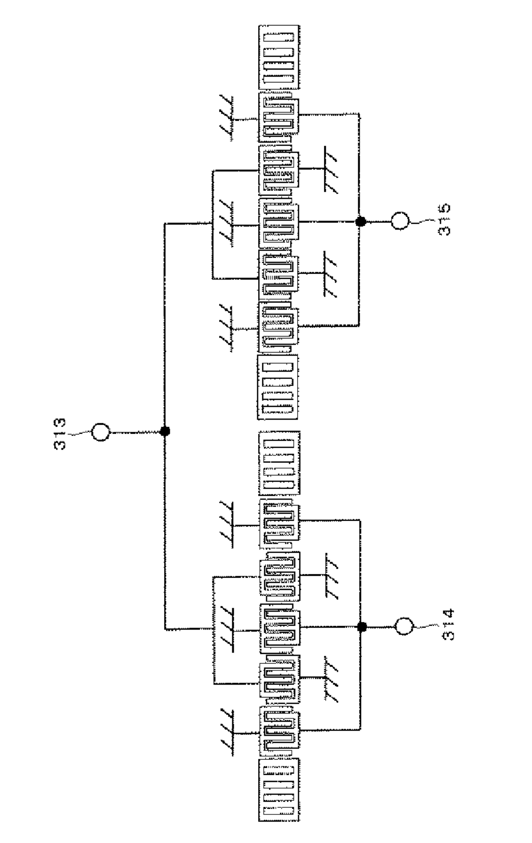
[Drawing 9]


(a)
S11
規格化インピーダンス 50Ω
(b)
S22
規格化インピーダンス 100Ω

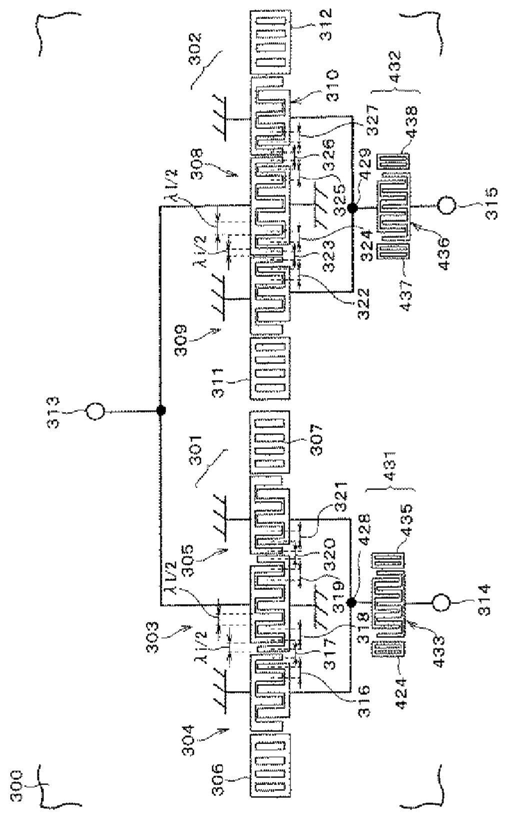
[Drawing 10]


VSWR
Frequency (MHz)
S11
S22
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
850
870
890
910
930
950

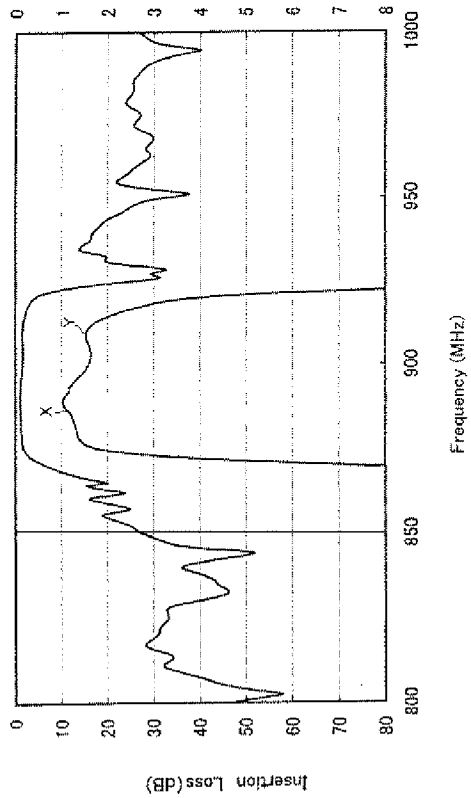
[Drawing 11]



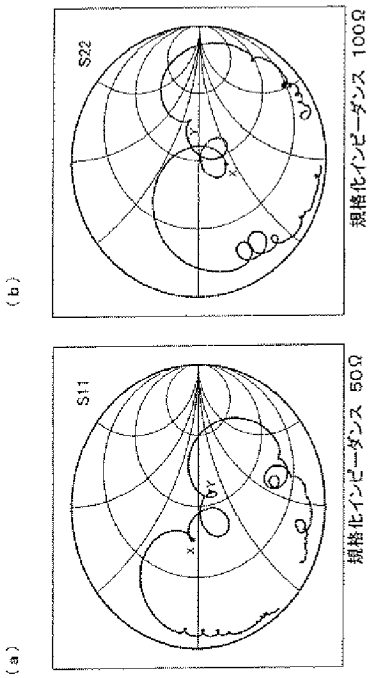
[Drawing 12]


300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
424
428
429
431
432
433
435
436
437
438
λ1/2

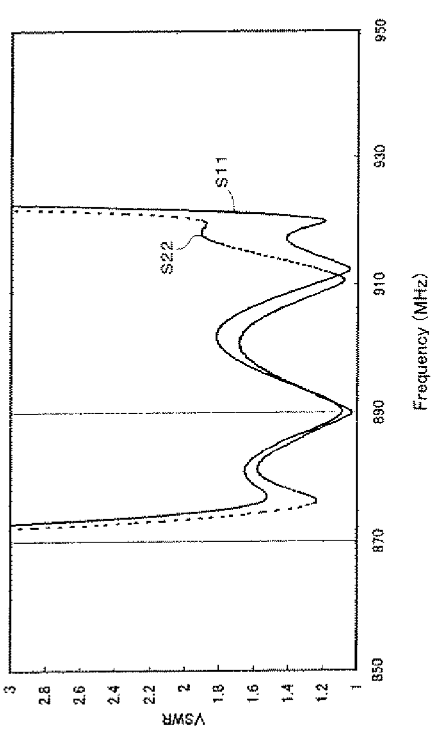
[Drawing 13]


Insertion Loss (dB)
Frequency (MHz)
X
Y
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
6
7
8
800
850
900
950
1000

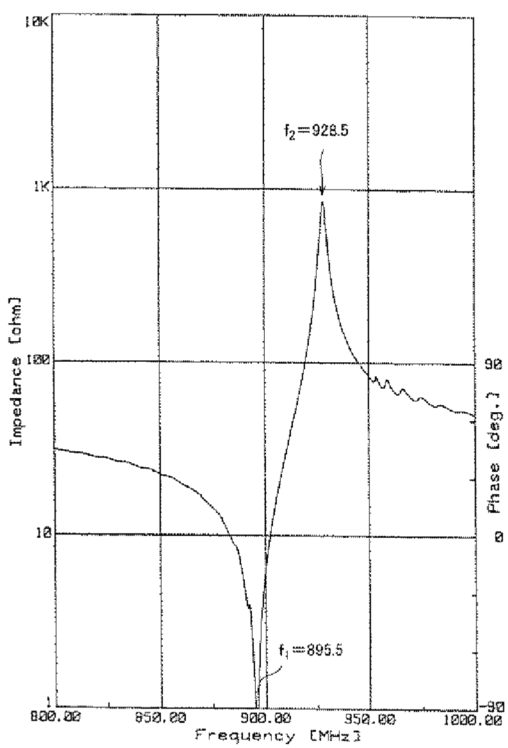
[Drawing 14]


(a)
S11
規格化インピーダンス 50Ω
(b)
S22
規格化インピーダンス 100Ω

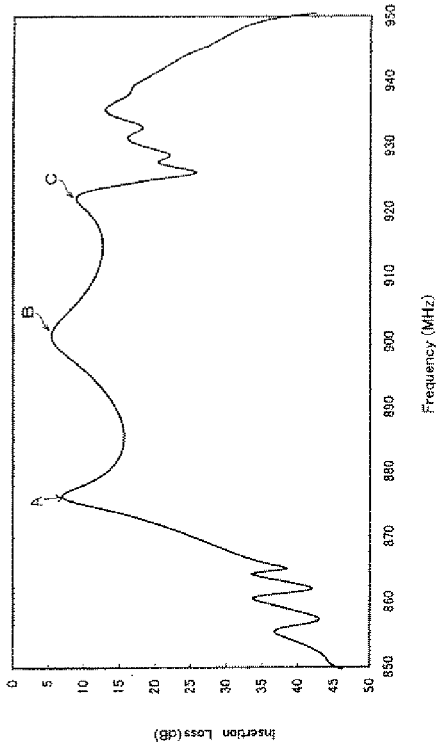
[Drawing 15]


VSWR
Frequency (MHz)
S11
S22

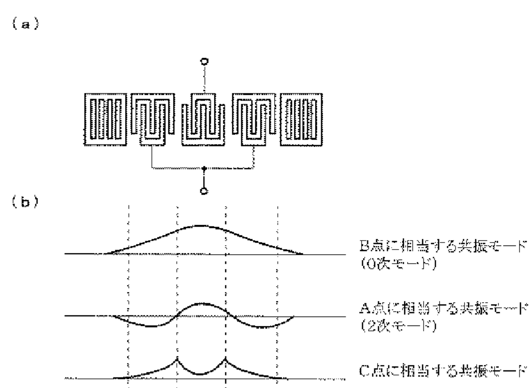
[Drawing 16]



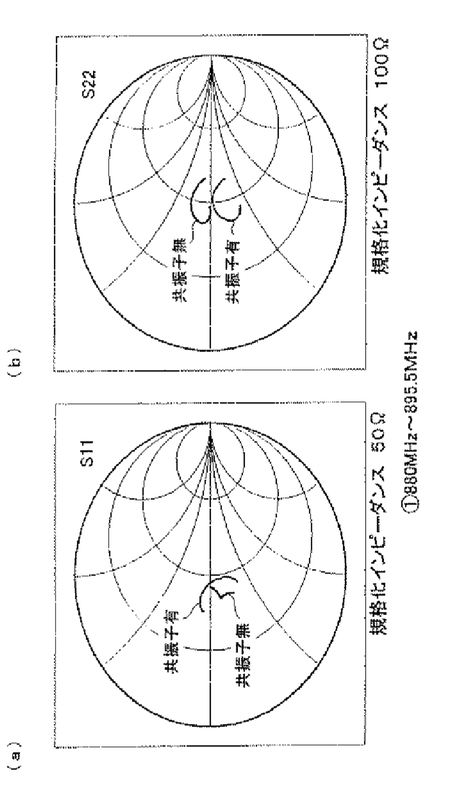
[Drawing 17]



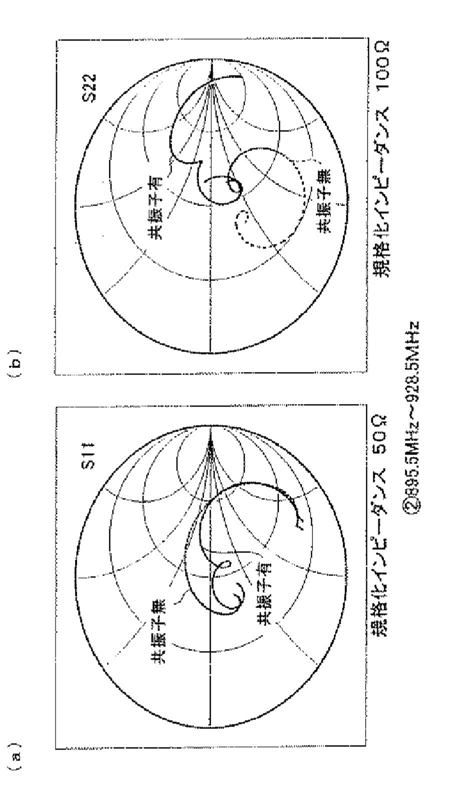
[Drawing 18]



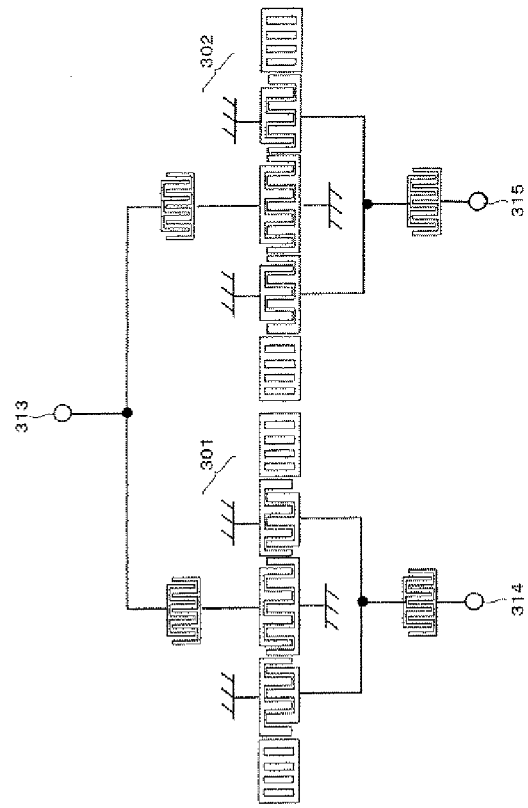
[Drawing 19]


（a）
S11
共振子有
共振子無
規格化インピーダンス 50Ω
（b）
S22
共振子無
共振子有
規格化インピーダンス 100Ω
①880MHz～895.5MHz

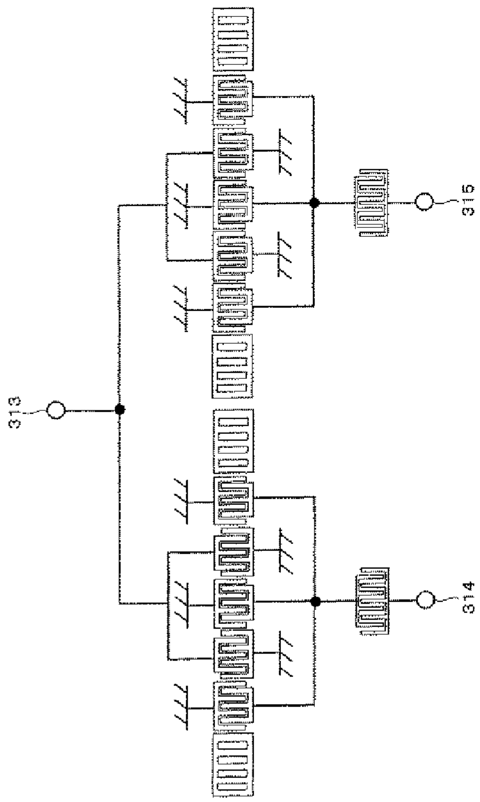
[Drawing 20]


(a)
S11
共振子無
共振子有
規格化インピーダンス 50Ω
(b)
S22
共振子有
共振子無
規格化インピーダンス 100Ω
②895.5MHz～928.5MHz

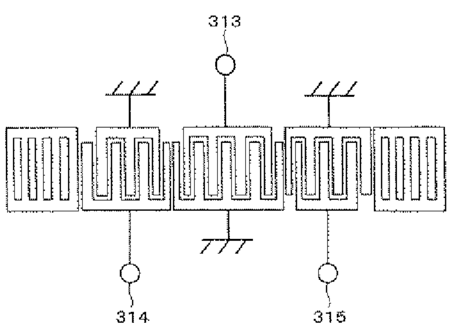
[Drawing 21]



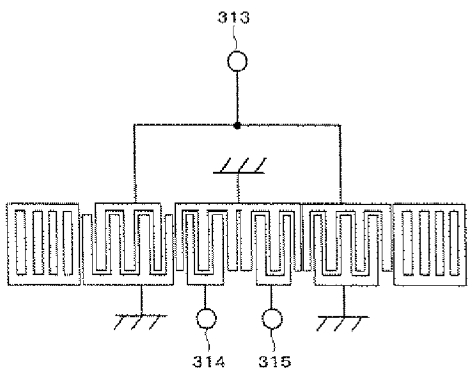
[Drawing 22]



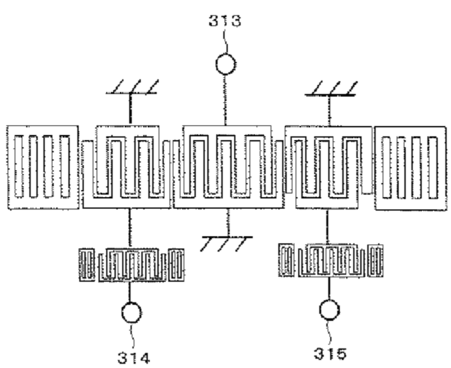
[Drawing 23]



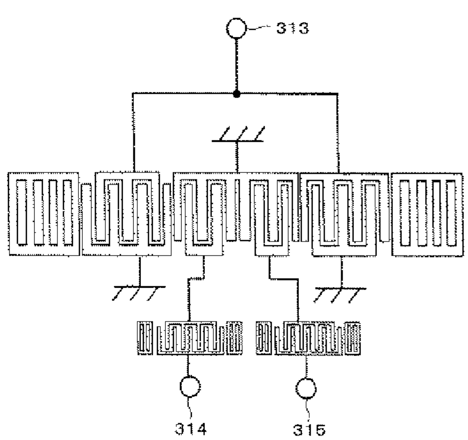
[Drawing 24]



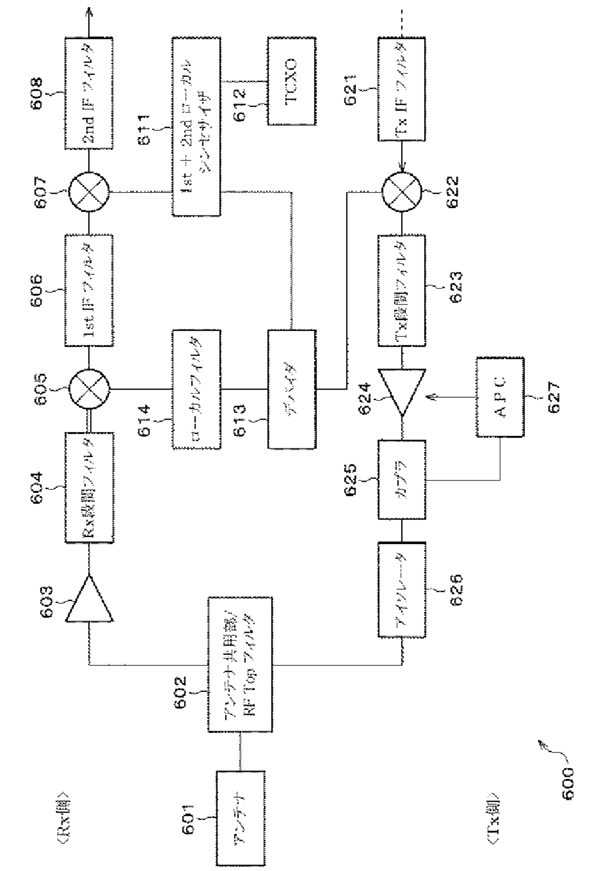
[Drawing 25]



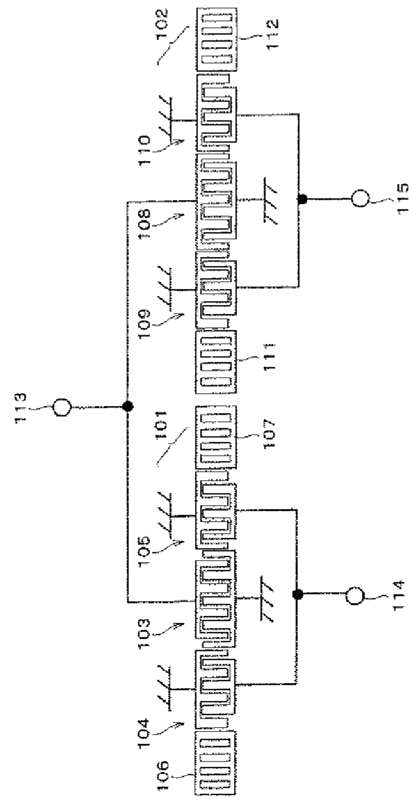
[Drawing 26]



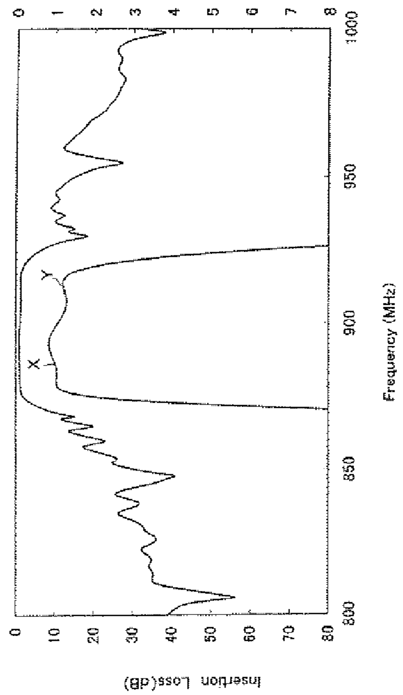
[Drawing 27]



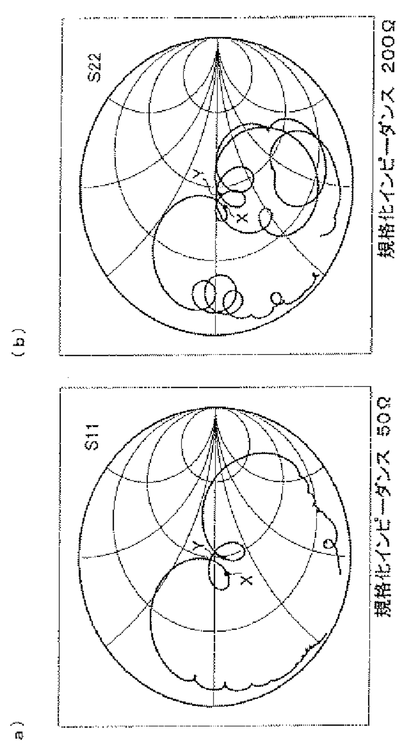
[Drawing 28]



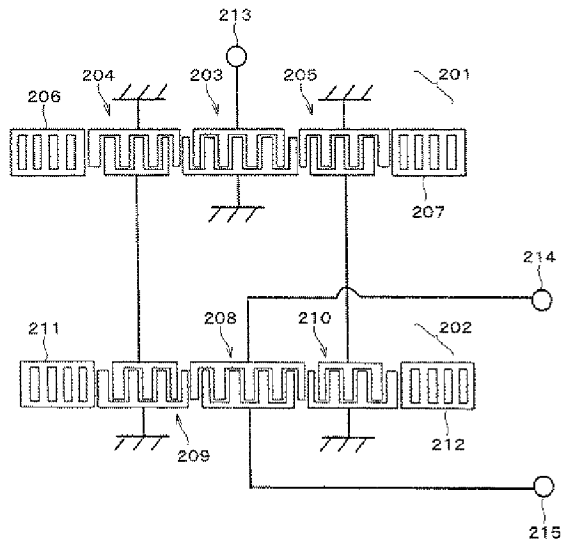
[Drawing 29]


Insertion Loss(dB)
Frequency (MHz)
800
850
900
950
1000
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
6
7
8
X
Y

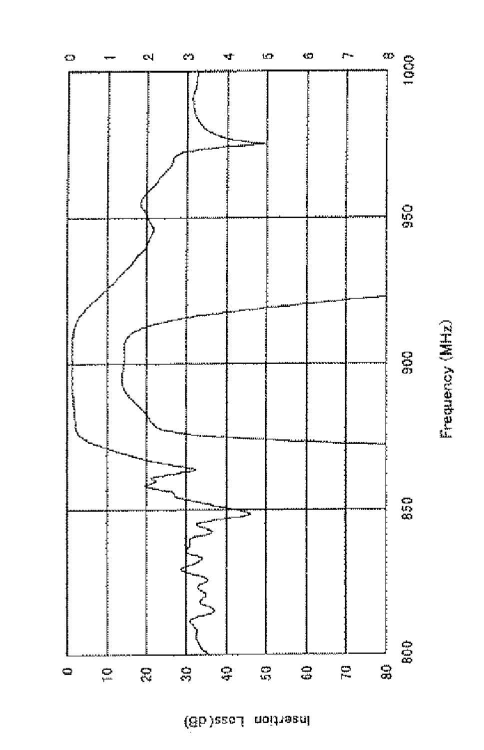
[Drawing 30]


(a)
S11
X
Y
規格化インピーダンス 50Ω
(b)
S22
X
Y
規格化インピーダンス 200Ω

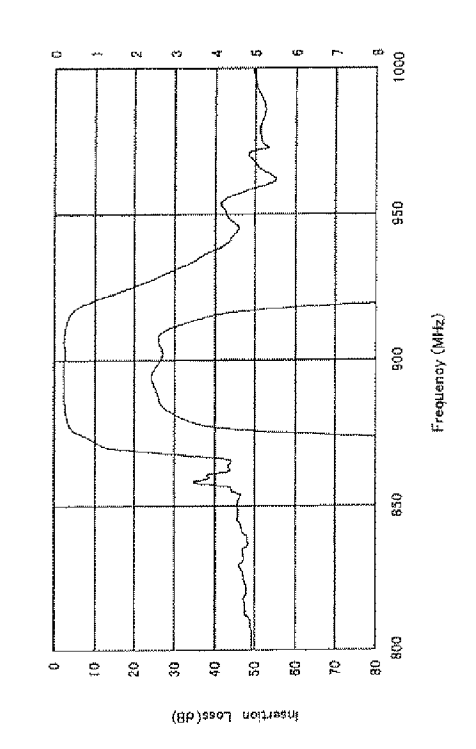
[Drawing 31]



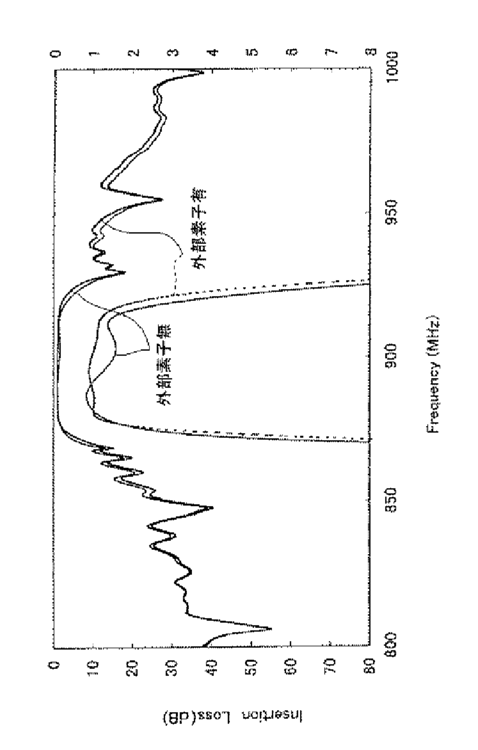
[Drawing 32]



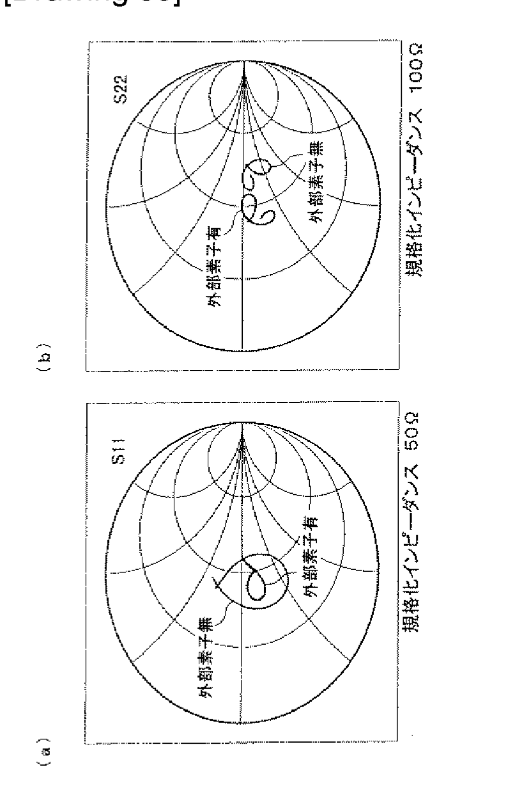
[Drawing 33]



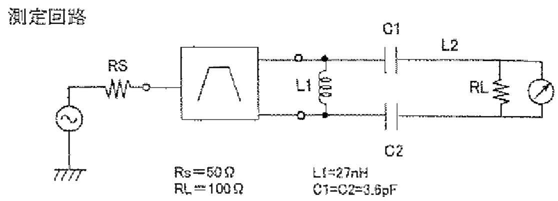
[Drawing 34]


Insertion Loss(dB)
Frequency (MHz)
外部素子有
外部素子無

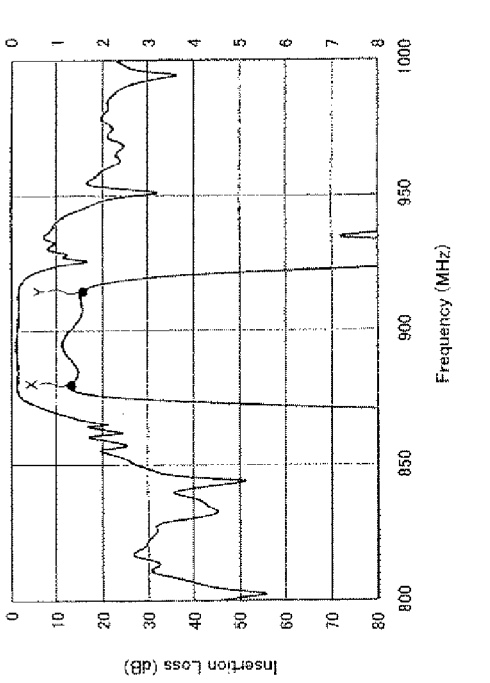
[Drawing 35]


(a)
S11
外部素子無
外部素子有
規格化インピーダンス 50Ω
(b)
S22
外部素子有
外部素子無
規格化インピーダンス 100Ω

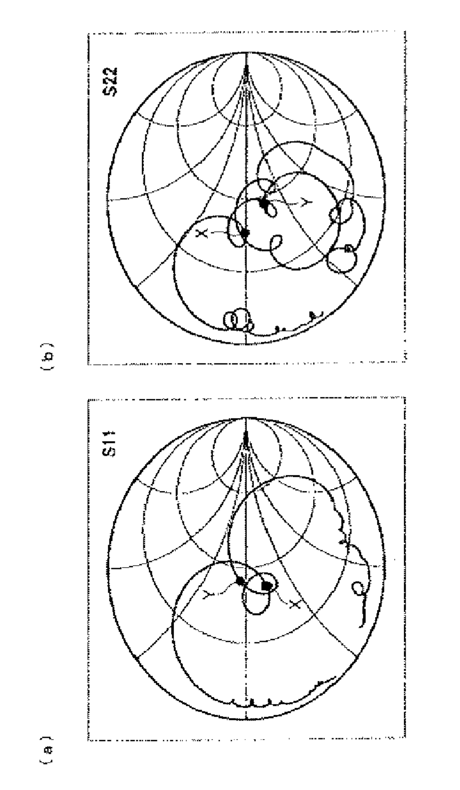
[Drawing 36]



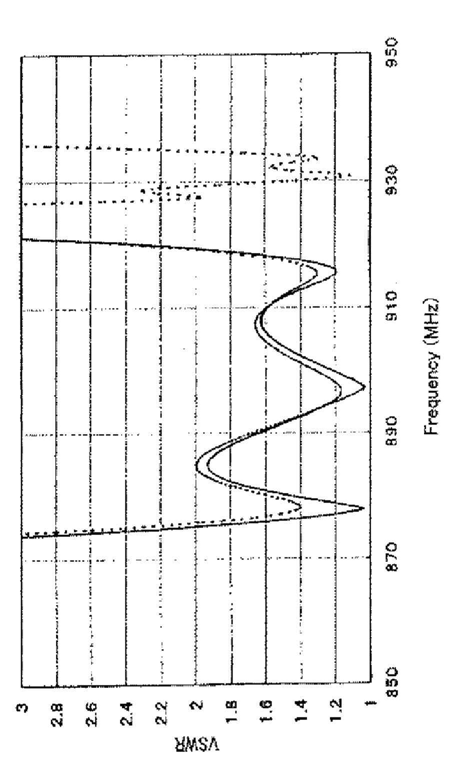
[Drawing 37]



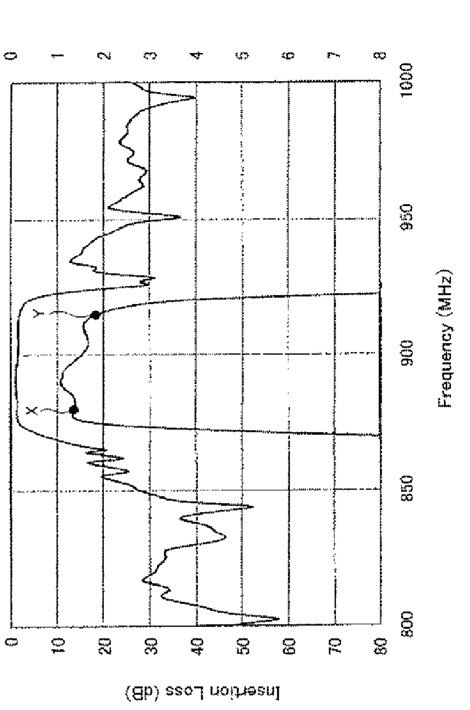
[Drawing 38]



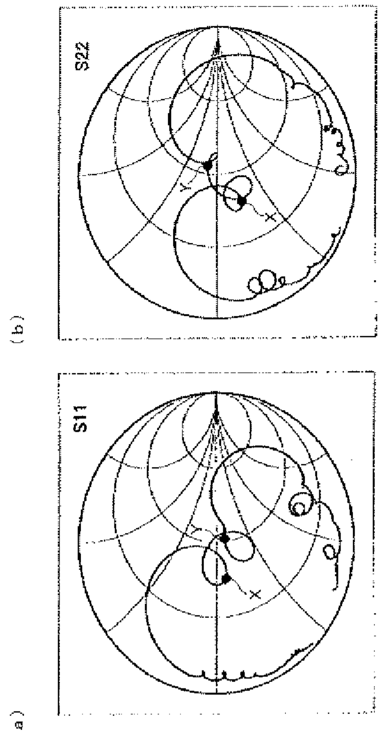
[Drawing 39]


VSWR
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
850
870
890
910
930
950
Frequency (MHz)

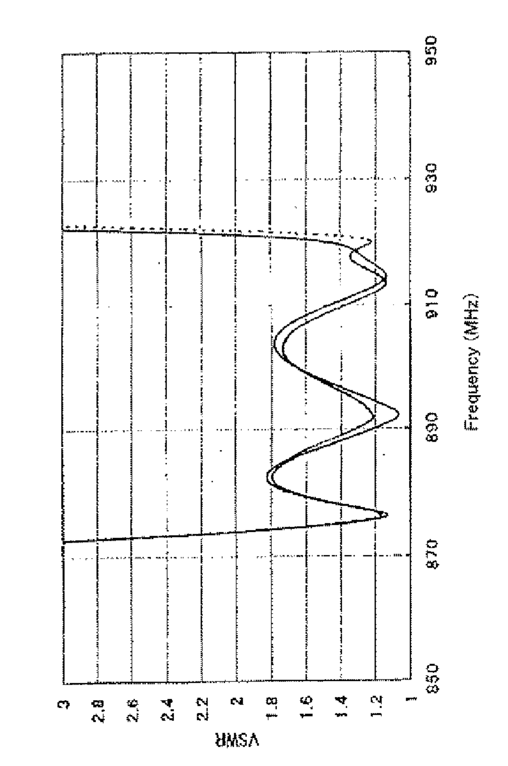
[Drawing 40]


Insertion Loss (dB)
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
6
7
8
800
850
900
950
1000
Frequency (MHz)
X
Y

[Drawing 41]



[Drawing 42]



[Translation done.]

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H03H 9/64	H03H	9/145	A	
	H03H	9/64	Z	

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(32)優先日　平成14年5月15日(2002.5.15)
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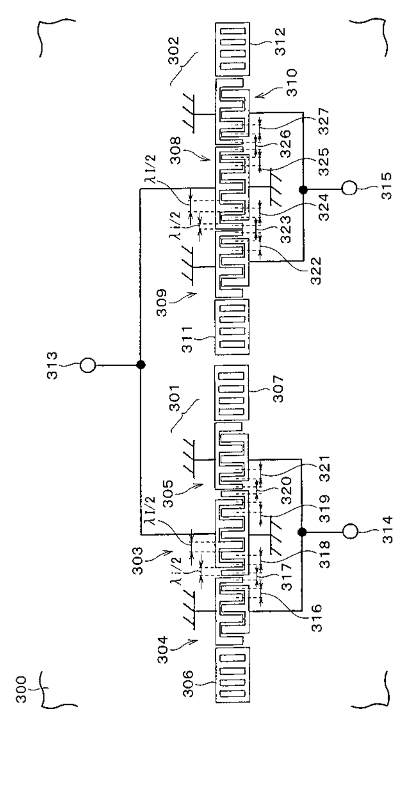
株式会社村田製作所内

Fターム(参考)　5J097 AA12 AA16 BB02 BB03 BB11
CC03 CC04 DD06 DD07 DD13
KK01 KK02 KK04

(54)【発明の名称】弾性表面波装置及びそれを有する通信装置

(57)【要約】
【課題】挿入損失の劣化を抑制しながら、平衡－不平衡変換が可能で、不平衡と平衡との間のインピーダンスが１：２ないし１：３に設定できて、簡素な構成の弾性表面波装置及びそれを有する通信装置を提供する。
【解決手段】平衡－不平衡変換機能を有するように複数のくし型電極部３０３、３０４、３０５、３０８、３０９、３１０を設ける。平衡信号端子３１４、３１４側に接続されたくし型電極部３０４、３０５、３０９、３１０の電極指総本数をＮ１、不平衡信号端子３１３側に接続されたくし型電極部３０３、３０８の電極指総本数Ｎ２とした場合、比率Ｎ２／Ｎ１を５０～７０％に設定する。くし型電極部３０３、３０４、３０５、３０８、３０９、３１０の電極交叉幅（Ｗ）を弾性表面波の波長λに対して４３λ～５８λの範囲に設定する。
【選択図】　図１



【特許請求の範囲】
【請求項１】
平衡－不平衡変換機能を有するように複数のくし型電極部を備えた弾性表面波装置において、
平衡信号端子側に接続されたくし型電極部の電極指総本数をＮ１、不平衡信号端子側に接続されたくし型電極部の電極指総本数Ｎ２とした場合、比率Ｎ２／Ｎ１が５０％～７０％であり、かつ前記くし型電極部の電極交叉幅（Ｗ）が弾性表面波の波長λに対して４３λ～５８λの範囲に設定されていることを特徴とする弾性表面波装置。
【請求項２】
前記くし型電極部の内、反射器に隣り合うくし型電極部と前記反射器とが互いに隣り合う箇所において、隣り合う電極指の中心間距離が前記反射器の電極周期λｒに対して０．４６λｒ～０．５４λｒであることを特徴とする請求項１に記載の弾性表面波装置。
【請求項３】
前記くし型電極部の電極周期により決まる周波数ｆｉｄｔが、前記反射器の電極周期により決まる周波数ｆｒｅｆに対して、（ｆｒｅｆ／ｆｉｄｔ）＝０．９９８～１．００８の範囲にて設定されていることを特徴とする請求項１又は２に記載の弾性表面波装置。
【請求項４】
圧電基板上に弾性表面波の伝搬方向に沿って形成された３つ以上の奇数個のくし型電極部を有する第１の弾性表面波フィルタと、入力信号に対し出力信号の位相が約１８０度異なる第２の弾性表面波フィルタを有し、前記第１、第２の弾性表面波フィルタにおけるそれぞれ一方の端子を電気的に並列に接続し、もう一方を電気的に直列に接続し、前記並列に接続した端子を不平衡信号端子、直列に接続した端子を平衡信号端子とすることで平衡－不平衡変換機能を有することを特徴とする請求項１ないし３の何れか１項に記載の弾性表面波装置。
【請求項５】
くし型電極部の数をｋとするとき、［（ｋ－１）／２］個のくし型電極部が、不平衡信号端子に接続され、｛［（ｋ－１）／２］＋１｝個のくし型電極部が、平衡信号端子にそれぞれ接続されていることを特徴とする請求項１ないし３の何れか１項に記載の弾性表面波装置。
【請求項６】
圧電基板上に弾性表面波の伝搬方向に沿って形成された１つの弾性表面波フィルタにおいて、入力信号に対し出力信号の位相の差が約０度となる第１の端子と、入力信号に対し出力信号の位相の差が約１８０度となる第２の端子とを有し、上記第１の端子と第２の端子とを互いに直列に接続することで、平衡－不平衡変換機能を有していることを特徴とする請求項１ないし３の何れか１項に記載の弾性表面波装置。
【請求項７】
複数のくし型電極部は、３つのくし型電極部を有する縦結合共振子型フィルタに設けられていることを特徴とする請求項１ないし６の何れか１項に記載の弾性表面波装置。
【請求項８】
少なくとも平衡信号端子側に接続されるくし型電極部に、少なくとも一つの弾性表面波共振子が電気的に直列に接続されていることを特徴とする、請求項１ないし７の何れか１項に記載の弾性表面波装置。
【請求項９】
各くし型電極部における共振モードの内、０次モードの励振周波数をｆ０、及びくし型電極部－くし型電極部の間に弾性表面波の強度分布のピークをもつ定在波共振モードの励振周波数をｆＮとし、弾性表面波共振子の共振周波数をｆ１、反共振周波数をｆ２としたとき、少なくとも両端に位置するくし型電極部に接続される端子に、それぞれ少なくとも一つの弾性表面波共振子が、ｆ１＜ｆ０＜ｆＮ＜ｆ２となるように、電気的に直列に接続されていることを特徴とする、請求項７に記載の弾性表面波装置。
【請求項１０】

不平衡信号端子と平衡信号端子のインピーダンスの関係が１：２ないし１：３となるように設定されていることを特徴とする、請求項１ないし９の何れか１項に記載の弾性表面波装置。

【請求項１１】

請求項１ないし１０の何れか１項に記載の弾性表面波装置を有することを特徴とする通信装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】

本発明は、携帯電話等の小型無線通信装置のフィルタに好適に使用される弾性表面波装置、特に平衡－不平衡変換機能を有し、入出力インピーダンスが異なる弾性表面波装置及びそれを有する通信装置に関するものである。

【０００２】

【従来の技術】

近年、携帯電話等の小型無線通信装置の小型化、軽量化に対する技術的進歩は目覚しいものがある。これを実現するための手段として、各構成部品の削減、小型化はもとより、複数の機能を複合した部品の開発も進んできた。

【０００３】

このような状況を背景に、携帯電話のＲＦ段に使用する弾性表面波フィルタに対して、平衡－不平衡変換機能、いわゆるバランの機能を備えることへの要求が強くなってきており、平衡－不平衡信号変換を容易に対応できる縦結合共振子型表面波フィルタが、携帯電話のＲＦ段のバンドパスフィルタとして主流になってきている。

【０００４】

この平衡－不平衡変換機能を備えた縦結合共振子型表面波フィルタは、平衡あるいは差動入出力を備えたミキサＩＣ（以下、平衡型ミキサＩＣという）に接続されて用いられることが多い。この平衡型ミキサＩＣを用いた場合、ノイズの影響の低減及び出力の安定化を図ることができ、携帯電話の特性向上を図ることができるため、近年、多く使われるようになった。

【０００５】

この平衡型ミキサＩＣのインピーダンスは、ＲＦ段に使用する弾性表面波フィルタが、通常５０Ωのインピーダンスを有するのに対し、多くの場合１００Ω～２００Ω程度と高い。中でも、これまでの主流は２００Ωであったため、平衡型ミキサＩＣと併用される縦結合共振子型表面波フィルタには、入力インピーダンスと出力インピーダンスが約４倍異なる特性を要求されていた。

【０００６】

入力インピーダンスと出力インピーダンスとが互いに約４倍異なる特性を得るには、図２８に示すように、特開２００１－２６７８８５号公報に開示されている構成が広く用いられている。図２８の構成は、縦結合共振子型の各弾性表面波素子１０１、１０２が、端子の一方を電気的に並列に、一方を直列に接続されている。

【０００７】

弾性表面波素子１０１と弾性表面波素子１０２との間にて互いに異なる点は、くし型電極部（以下、ＩＤＴと記す）１０３とＩＤＴ１０８とが、位相の点で互いに反転していることである。これにより、端子１１４と端子１１５とから出力される信号の位相は、ほぼ１８０度異なり、端子１１３から入力される不平衡信号が端子１１４と端子１１５とから出力される平衡信号に変換される。

【０００８】

また、図２８の構成での周波数特性及びインピーダンス特性をそれぞれ図２９、図３０（ａ）及び（ｂ）に示す。図２９の特性は、ＥＧＳＭ（Ｅｎｈａｎｃｅｄ Ｇｌｏｂａｌ Ｓｙｓｔｅｍ ｆｏｒ Ｍｏｂｉｌｅ ｃｏｍｍｕｎｉｃａｔｉｏｎｓ）送信用フィルタとして設計されたもので、通過帯域に必要な周波数範囲は８８０ＭＨｚ～９１５ＭＨｚで

ある。ｆ＝８８０ＭＨｚのポイントをＸ、ｆ＝９１５ＭＨｚのポイントをＹとして、図３０（ａ）及び（ｂ）にプロットする。
【０００９】
図３０（ａ）及び（ｂ）から分かるように、図１の構成にて設計した場合通過帯域におけるインピーダンスは不平衡側（Ｓ１１）５０Ωに対し、平衡側（Ｓ２２）２００Ωの終端インピーダンスは、ほぼ整合が取れており、平衡信号側のインピーダンスが不平衡信号側のインピーダンスの約４倍となる特性が得られる。
【００１０】
一方で、前述したが平衡型ミキサＩＣによってはインピーダンスが１００Ω付近の場合もあり、それに応じて縦結合共振子型表面波フィルタも、不平衡信号端子側のインピーダンスと平衡信号端子側のインピーダンスが約２倍異なる特性を要求される場合もある。
【００１１】
日本国特許第３２２４２０２号公報では、図３１の様な不平衡－平衡入出力対応フィルタを構成してその解決法を提示している。図３１の構成を説明すると、２つの縦結合共振子型の各弾性表面波素子２０１、２０２をそれぞれＩＤＴ２０４とＩＤＴ２０９、ＩＤＴ２０５とＩＤＴ２１０にてカスケード接続した構成となっており、端子２１３が不平衡信号端子であり、端子２１３から入力した信号はＩＤＴ２０８にて位相がそれぞれ約１８０度異なる信号として各平衡信号端子２１４、２１５に出力される。
【００１２】
日本国特許第３２２４２０２号公報においては、図３１の構成にて各弾性表面波素子２０１、２０２の交叉幅Ｗを互いに異ならせることで、不平衡信号端子側のインピーダンスと平衡信号端子側のインピーダンスが異なる場合でも、所望の特性を得る事が出来るとしている。
【００１３】
【発明が解決しようとする課題】
しかしながら、図３１の構成では、広帯域、低損失かつ高平衡度という近年の要求を満足する特性を得る事はできない。一つは、２つの各弾性表面波素子２０１、２０２をカスケード接続した場合、挿入損失は当然のことながら２素子分の値となる。その上、１段目と２段目の交叉幅を変えるため、段間部での不整合が発生し、更に挿入損失が大きくなる。
【００１４】
参考に１つの弾性表面波素子での周波数特性を図３２に、その弾性表面波素子を２つ用い、カスケード接続した場合の周波数特性を図３３に示す。一つは、図３１の構成の場合、ＩＤＴ２０８にて位相が１８０度異なる信号を平衡信号端子２１４及び端子２１５に出力する構成となっているが、ＩＤＴ電極あるいは基板上における配線を非対称に構成せざるを得ず、出力信号の振幅・位相平衡度に影響するため、図２８の構成に比べて平衡度は悪化する。
【００１５】
以上の事から、図３１の構成は低損失かつ平衡度の要求レベルの高い不平衡－平衡入出力対応フィルタには不向きであり、専ら図２８の構成が用いられる。
【００１６】
以下では、図２８の構成において不平衡信号端子１１３を入力側、平衡信号端子１１４、１１５を出力側として説明する。図２８の構成にて弾性表面波素子１０１、１０２の入出力端子のインピーダンスをＲｉ、Ｒｏとした場合、不平衡信号端子側のインピーダンスは弾性表面波素子１０１、１０２の入力側の端子が電気的に並列に接続されるためＲｉ／２、平衡信号端子側のインピーダンスは弾性表面波素子１０１、１０２の出力側の端子が電気的に直列に接続されるため２Ｒｏとなる。
【００１７】
通常、３つのＩＤＴにて弾性表面波素子１０１、１０２を設計した場合、入出力のインピーダンスは近い値になることから、Ｒｉ≒Ｒｏが成り立つ。従って、前述した様な平衡信号端子側のインピーダンスが不平衡側のインピーダンスに対して約４倍異なる不平衡－平

衡入出力フィルタを構成するためには、４×Ｒｉ／２≒２Ｒｏ、すなわちＲｉ≒Ｒｏとなり、設計は容易である。

【００１８】

一方、平衡信号端子側のインピーダンスが不平衡信号端子側のインピーダンスに対し約２倍異なる不平衡－平衡変換機能を構成するためには、２×Ｒｉ／２≒２Ｒｏ、すなわち２Ｒｉ≒Ｒｏとなるような弾性表面波素子１０１、１０２を設計する必要があり、設計上困難であると言える。

【００１９】

従来の方法の一つに、Ｒｉ≒Ｒｏとなっている弾性表面波素子にて平衡信号端子側のインピーダンスが不平衡信号端子側のインピーダンスに対して約４倍異なる不平衡－平衡変換機能を有する弾性表面波装置を構成し、平衡信号端子側にインダクタンス素子を並列に、さらにキャパシタンス素子を直列に付加する（もしくはキャパシタンス素子を並列に、インダクタンス素子を並列に付加）など、弾性表面波装置の外にマッチング素子を付加することで不平衡－平衡信号端子のインピーダンスの関係を約２倍異なるように整合を取るという方法も用いられてきた。

【００２０】

図３０の特性を不平衡－平衡信号端子のインピーダンスの関係を約２倍異なるように整合を取った時の周波数特性を図３４、インピーダンス特性（８８０ＭＨｚ～９１５ＭＨｚの範囲）を図３５（ａ）、（ｂ）に、外部素子を付加した測定回路を図３６に示す。尚、図３４、図３５（ａ）、（ｂ）では、比較のために外部素子無しのときの特性も示した。図３４、図３５（ａ）、（ｂ）に示すように、この方法にて、不平衡－平衡信号端子のインピーダンスの関係を約２倍異なるようにすることは可能であるが、外部素子の付加による構成部品の増加、それに伴う小型化の弊害になるといった問題があった。

【００２１】

このような問題は、不平衡－平衡信号端子のインピーダンスの関係を約２倍異なるようにするときだけではなく、不平衡－平衡信号端子のインピーダンスの関係を約３倍異なるようにするときにおいても同様に生じる。

【００２２】

【課題を解決するための手段】

本発明の弾性表面波装置は、上記課題を解消するために、平衡－不平衡変換機能を有するように複数のＩＤＴを備えた弾性表面波装置において、平衡信号端子側に接続されたＩＤＴの電極指総本数をＮ１、不平衡信号端子側に接続されたＩＤＴの電極指総本数Ｎ２とした場合、比率Ｎ２／Ｎ１が５０～７０％であり、かつ前記ＩＤＴの電極交叉幅（Ｗ）が弾性表面波の波長λに対して４３λ～５８λの範囲に設定されていることが特徴としている。

【００２３】

上記構成によれば、上記設定により、不平衡信号端子と平衡信号端子のインピーダンスの関係を、新たな外部素子等の付加を省いて、簡素な構成により１：２ないし１：３にできる。

【００２４】

上記弾性表面波装置では、前記ＩＤＴのうち反射器に隣り合うＩＤＴと前記反射器とが互いに隣り合う箇所において、隣り合う電極指の中心間距離が前記反射器の電極周期λｒに対して０．４６λｒ～０．５４λｒであることが好ましい。

【００２５】

上記弾性表面波装置においては、前記ＩＤＴの電極周期により決まる周波数ｆｉｄｔが、前記反射器の電極周期により決まる周波数ｆｒｅｆに対して、（ｆｒｅｆ／ｆｉｄｔ）＝０．９９８～１．００８の範囲にて設定されていてもよい。

【００２６】

上記弾性表面波装置では、圧電基板上に弾性表面波の伝搬方向に沿って形成された３つ以上の奇数個のＩＤＴを有する第１の弾性表面波フィルタと、入力信号に対し出力信号の位

相が約１８０度異なる第２の弾性表面波フィルタを有し、前記第１、第２の弾性表面波フィルタにおけるそれぞれ一方の端子を電気的に並列に接続し、もう一方を電気的に直列に接続し、前記並列に接続した端子を不平衡信号端子、直列に接続した端子を平衡信号端子とすることで平衡－不平衡変換機能を有していてもよい。

【００２７】
上記弾性表面波装置においては、ＩＤＴの数をｋとするとき、［（ｋ－１）／２］個のＩＤＴが、不平衡信号端子に接続され、｛［（ｋ－１）／２］＋１｝個のＩＤＴが、平衡信号端子にそれぞれ接続されていてもよい。

【００２８】
上記弾性表面波装置では、圧電基板上に弾性表面波の伝搬方向に沿って形成された１つの弾性表面波フィルタにおいて、入力信号に対し出力信号の位相の差が約０度となる第１の端子と、入力信号に対し出力信号の位相の差が約１８０度となる第２の端子とを有し、上記第１の端子と第２の端子とを互いに直列に接続することで、平衡－不平衡変換機能を有していてもよい。

【００２９】
上記弾性表面波装置においては、複数のＩＤＴは、３つのＩＤＴを有する縦結合共振子型フィルタに設けられていてもよい。

【００３０】
上記弾性表面波装置では、少なくとも平衡信号端子側に接続されるＩＤＴに、少なくとも一つの弾性表面波共振子が電気的に直列に接続されていてもよい。

【００３１】
上記構成によれば、少なくとも平衡信号端子側に接続されるＩＤＴに、少なくとも一つの弾性表面波共振子を電気的に直列に接続したことにより、さらに、通過帯域外の減衰量を大きくできるから、フィルタ特性を向上できる。

【００３２】
上記弾性表面波装置においては、各ＩＤＴにおける共振モードの内、０次モードの励振周波数をｆ０、及びＩＤＴ－ＩＤＴの間に弾性表面波の強度分布のピークをもつ定在波共振モードの励振周波数をｆＮとし、弾性表面波共振子の共振周波数をｆ１、反共振周波数をｆ２としたとき、少なくとも両端に位置するＩＤＴに接続される端子に、それぞれ少なくとも一つの弾性表面波共振子が、ｆ１＜ｆ０＜ｆＮ＜ｆ２となるように、電気的に直列に接続されていてもよい。

【００３３】
上記弾性表面波装置では、不平衡信号端子と平衡信号端子のインピーダンスの関係が１：２ないし１：３となるように設定されていることが望ましい。

【００３４】
本発明の通信装置は、前記の課題を解消するために、上記の何れかに記載の弾性表面波装置を有していることを特徴としている。

【００３５】
上記構成によれば、用いた弾性表面波装置は、フィルタ機能と共に平衡型－不平衡変換機能を備えることができ、その上、不平衡信号端子と平衡信号端子のインピーダンスの関係を１：２ないし１：３にでき、また、通過帯域外の減衰量に優れた特性を有するものである。よって、上記弾性表面波装置を有する本発明の通信装置は、伝送特性を向上できるものとなっている。

【００３６】
【発明の実施の形態】
本発明に係る実施の各形態の弾性表面波装置及びそれを備えた通信装置を図１ないし図２７、並びに図３７ないし図４２に基づいて以下に説明する。

【００３７】
本発明に係る弾性表面波装置における実施の第一形態は、図１に示すように、不平衡信号端子３１３側の終端インピーダンスが５０Ω、各平衡信号端子３１４、３１５側の終端イ

ンピーダンスが１００Ωで、不平衡－平衡信号端子のインピーダンスが約２倍となる構成のＥＧＳＭ送信用フィルタとして設計したものである。なお、ＥＧＳＭ送信用フィルタの通過帯域に必要な周波数範囲は８８０ＭＨｚ～９１５ＭＨｚであり、中心周波数は８９７．５ＭＨｚである。

【００３８】
実施の第一形態では、４０±５°ＹｃｕｔＸ伝搬ＬｉＴａＯ３　からなる圧電基板３００上に弾性表面波フィルタがＡｌ電極により形成されている。実施の第一形態の構成を詳細に説明すると、ＩＤＴ３０３の左右（弾性表面波の伝搬方向に沿ってＩＤＴ３０３を挟むように）に各ＩＤＴ３０４、３０５を配置し、さらにこれらのＩＤＴ３０４、３０３、３０５を左右から挟み込むように、各リフレクタ３０６、３０７が形成された縦結合共振子型弾性表面波素子３０１が形成されている。

【００３９】
同様に、ＩＤＴ３０８の左右に各ＩＤＴ３０９、３１０を配置し、これらのＩＤＴ３０９、３０８、３１０を挟み込むように、リフレクタ３１１、３１２が形成された縦結合共振子型弾性表面波素子３０２が弾性表面波素子３０１に対し、出力信号の位相関係が１８０度異なるように形成されている。

【００４０】
ここで、ＩＤＴ３０３、３０４、３０５、３０８、３０９、３１０は一部箇所の電極指のピッチがＩＤＴの他の箇所より小さくなっている（狭ピッチ電極指）。ちなみに図１では図を簡潔にするために電極指の本数を少なく示している。端子３１３は不平衡信号端子、端子３１４と端子３１５は平衡信号端子である。

【００４１】
次に、図１の構成において、各弾性表面波素子３０１、３０２の交叉幅をＷ［μｍ］、ＩＤＴのピッチで決まる波長をλＩ［μｍ］としたとき、交叉幅の波長比Ｗ／λＩ、また、不平衡信号端子３１３に接続されたＩＤＴ３０３、３０８の電極指総数をＮ１、平衡信号端子３１４、３１５に接続されたＩＤＴ３０４、３０５、３０９、３１０の電極指総数をＮ２としたとき、不平衡信号端子３１３、各平衡信号端子３１４、３１５に接続された電極指の比率はＮ２／Ｎ１［％］（以下、電極指数比とする）となる。

【００４２】
図２及び図３は、交叉幅Ｗ／λＩをＸ軸とし、比帯域幅の依存性、及び複数の電極指数比Ｎ２／Ｎ１でみた時のＶＳＷＲ（Ｖｏｌｔａｇｅ　Ｓｔａｎｄｉｎｇ　Ｗａｖｅ　Ｒａｔｉｏ）をそれぞれ示している。ＥＧＳＭ送信用フィルタの場合、必要通過帯域幅が３５ＭＨｚであるのに対し、温度変化マージン、製造公差マージンを考慮すると４４ＭＨｚの帯域幅を必要とする。つまり、比帯域幅は４４ＭＨｚ／８９２．５ＭＨｚ＝４．９％以上であることが望ましい。

【００４３】
また、通過帯域におけるインピーダンスは、できる限り終端インピーダンスに近いことが望ましい。終端インピーダンスをＺＬ　、弾性表面波装置の特性インピーダンスをＺ０　とすると、反射係数Γ＝（ＺＬ　－Ｚ０　）／（ＺＬ　＋Ｚ０　）で表され、ＶＳＷＲは（１＋｜Γ｜）／（１－｜Γ｜）となる。したがって、弾性表面波装置の終端インピーダンスからのずれの指標としてＶＳＷＲを用いた。ＶＳＷＲは市場からの要求レベルから考えても多くとも２．０（つまり２．０以下）とする必要がある。

【００４４】
図２において、求められる比帯域幅４．９％以上を満たすのは、電極指数比Ｎ２／Ｎ１が５０％よりも上であるか、５０％で交叉幅Ｗが４３λＩ以上のときである。ここから、電極指数比Ｎ２／Ｎ１が５０％以上、交叉幅Ｗでは４３λＩ以上が好ましいことを導き出すことができる。

【００４５】
次に、図３において、求められるＶＳＷＲ＝２以下を満たすのは、上記の電極指数比Ｎ２／Ｎ１が５０％以上ということから、交叉幅は、５８λＩ以下が好ましく、かつ、上記の

交叉幅Ｗが４３λＩ以上ということから、電極指数比Ｎ２／Ｎ１では７０％以下が望ましいことが分かる。

【００４６】

よって、要求される比帯域幅が４．９％以上、かつＶＳＷＲが２以下を満たすのは、電極指数比Ｎ２／Ｎ１が５０％以上、７０％以下、かつ交叉幅は４３λＩ以上、５８λＩ以下のときである。

【００４７】

次に、電極指数比Ｎ２／Ｎ１をＸ軸とし、複数のＩＤＴ－リフレクタ間隔［Ｉ－Ｒ　ｇａｐ（λｒ）］でみた時のＶＳＷＲ及び比帯域幅の依存性を図４、図５に示す。この時、交叉幅Ｗ／λＩは５０．５λＩに固定している。図４を見ると、電極指数比Ｎ２／Ｎ１は５０％以上７０％以下の範囲において、ＶＳＷＲが２．０以下となるのは、リフレクタのピッチで決まる波長をλｒ［μｍ］とした時、ＩＤＴ－リフレクタ間隔０．５４λｒ以下のときである。また、図５に注目すると、比帯域幅が４．９％以上となるのは、ＩＤＴ－リフレクタ間隔０．４６λｒ以上の時である。

【００４８】

以上のことから、電極指数比Ｎ２／Ｎ１が、５０％以上、７０％以下の範囲において、ＩＤＴ－リフレクタ間隔は、０．４６λｒ以上、０．５４λｒ以下であることが望ましいと言える。

【００４９】

また、リフレクタの音速、ピッチにより決まる周波数をｆｒｅｆ、ＩＤＴの音速、ピッチにより決まる周波数をｆｉｄｔとしたときＩＤＴの周波数に対するリフレクタの周波数の比（以下、周波数比という）をｆｒｅｆ／ｆｉｄｔとする。図６、図７ＢにＩＤＴ－リフレクタ間隔をＸ軸とし、複数の周波数比ｆｒｅｆ／ｆｉｄｔでみた時のＶＳＷＲ及び比帯域幅の依存性にそれぞれ示す。この時、交叉幅Ｗ／λＩは５０．５λＩ、電極指数比Ｎ２／Ｎ１は約６０％に固定している。

【００５０】

図６に注目すると、ＩＤＴ－リフレクタ間隔が大きくなるにつれＶＳＷＲは大きくなる傾向があり、ＩＤＴ－リフレクタ間隔が０．４６λｒ以上、０．５４λｒ以下の範囲にてＶＳＷＲ２．０以下を満足するためには、周波数比ｆｒｅｆ／ｆｉｄｔは０．９９３以上、１．００８以下であることが好ましいと言える。

【００５１】

次に図７に注目すると、ＩＤＴ－リフレクタ間隔に対して比帯域幅は上に凸な放物線状に変化する傾向にある。ＩＤＴ－リフレクタ間隔が０．４６λｒ以上０．５４λｒ以下の範囲においては、周波数比ｆｒｅｆ／ｆｉｄｔが０．９９３以上、１．００３以下の範囲で最も安定し、それ以外では勾配の大きい領域にあるため、ＩＤＴ－リフレクタ間隔に対する特性の変化が大きく不安定になる。以上のことより、周波数比ｆｒｅｆ／ｆｉｄｔは、０．９９３以上、１．００３以下の範囲であることがより望ましいと言える。

【００５２】

本実施の第一形態の構成にて、上記した最適な範囲内のパラメータを用いて設計した時の周波数特性を図８に、インピーダンス特性を図９（ａ）、図９（ｂ）に、反射特性（ＶＳＷＲ）を図１０にそれぞれ示す。なお、このときの規格化インピーダンスは不平衡端子側が５０Ω、平衡端子側が１００Ωであり、１：２の関係になっている。

【００５３】

また、図８ないし図１０の特性が得られた時の縦結合共振子型の各弾性表面波素子３０１、３０２の詳細な設計を以下に示す。尚、以下では狭ピッチ電極指のピッチで決まる波長をそれぞれλｉ、その他の電極指のピッチで決まる波長をそれぞれλＩ、リフレクタの波長をそれぞれλＲとする。

・交叉幅Ｗ：２２８μｍ（５１λＩ）

・ＩＤＴ本数（３０４、３０３、３０５の順）：２９（４）／（３）３５（３）／（４）２９本（カッコ内は狭ピッチ電極指の本数、３０９、３０８、３１０も同じ）

・平衡信号端子に接続された電極指の本数Ｎ１：１３２本
・不平衡信号端子側に接続された電極指の本数Ｎ２：８２本（Ｎ２／Ｎ１＝６２．１％）
・不平衡信号端子側に接続された電極指の本数Ｎ２：８２本（Ｎ２／Ｎ１＝６２．１％）
・リフレクタ本数：９０本
・（リフレクタ周波数ｆｒｅｆ）／（ＩＤＴ周波数ｆｉｄｔ）：０．９９８
・ＩＤＴ－リフレクタ間隔：０．５０λＲ

ｆ＝８８０ＭＨｚのポイントをＸ、ｆ＝９１５ＭＨｚのポイントをＹとして、図９（ａ）及び図９（ｂ）に示すインピーダンス特性にプロットすると、通過帯域のインピーダンスはＳ１１が４３Ω～４６Ωで５０Ωからやや低めだが、ほぼ規格化インピーダンスにて整合が取れている。また、Ｓ２２は整合点に対してＸ～Ｙ点のインピーダンスはやや高めにずれた格好になってはいるが、ほぼ規格化インピーダンスにて整合が取れていると言える。これにより、不平衡信号端子と平衡信号端子とのインピーダンスの関係はほぼ１：２となることになる。

【００５４】

また、図１の構造において、図８ないし図１０の特性が得られた条件にて、規格化インピーダンスを不平衡信号端子側が５０Ω、平衡信号端子側が１５０Ωとし、１：３の関係としたときの周波数特性を図３７に、インピーダンス特性を図３８（ａ）及び図３８（ｂ）に、反射特性（ＶＳＷＲ）を図３９に、それぞれ示す。

【００５５】

Ｓ２２のインピーダンスに着目すると、整合点に対してＸ～Ｙ点のインピーダンスはやや低めにずれているが、ＶＳＷＲは２．０以内に収まっており、ほぼ規格化インピーダンスで整合がとれている。これにより、前記した最適な範囲内のパラメータを用いて設計すれば、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３とすることも可能と言える。

【００５６】

このときの各弾性表面波素子３０１、３０２の詳細な設計を下記に示す。なお、以下では狭ピッチ電極指のピッチで決まる波長をそれぞれλｉ、その他の電極指のピッチで決まる波長をそれぞれλＩ、リフレクタの波長をそれぞれλＲとする。

・交叉幅Ｗ：２２８μｍ（５１λＩ）
・ＩＤＴ本数（３０４、３０３、３０５の順）：２９（４）／（３）３５（３）／（４）２９本（カッコ内は狭ピッチ電極指の本数、３０９、３０８、３１０も同じ）
・平衡信号端子に接続された電極指の本数Ｎ１：１３２本
・不平衡信号端子側に接続された電極指の本数Ｎ２：８２本（Ｎ２／Ｎ１＝６２．１％）
・リフレクタ本数：９０本
・（リフレクタ周波数ｆｒｅｆ）／（ＩＤＴ周波数ｆｉｄｔ）：０．９９８
・ＩＤＴ－リフレクタ間隔：０．５０λＲ

このように不平衡信号端子と平衡信号端子のインピーダンスの関係が１：２ないし１：３となるような特性を得るためには、ＩＤＴの個数をｎ個とした場合に、第１、第２の弾性表面波素子における（ｎ－１）／２個のＩＤＴにてそれぞれを電気的に並列に接続して不平衡信号端子とし、｛［（ｎ－１）／２］＋１｝個のＩＤＴにて電気的に直列に接続し、直列に接続した端子を平衡信号端子とした図１のような構成は、一つの弾性表面波素子における入出力ＩＤＴの対数関係が通常の設計の場合により近い状態に保てることから、より望ましいと言える。

【００５７】

なお、上記では、弾性表面波素子として３つのＩＤＴを用いた縦結合共振子型の例を挙げたが、図１１に示すように、５つのＩＤＴを用いた縦結合共振子型の弾性表面波素子をそれぞれ用いてもよい。また、実施の第一形態では２つの弾性表面波素子を用いているが、図２３もしくは図２４のように１つの弾性表面波フィルタによる平衡－不平衡変換機能を有する弾性表面波素子においても同じことが言える。

【００５８】

以上説明したように実施の第一形態では、平衡－不平衡変換機能を有する弾性表面波装置において、平衡信号端子側に接続されたＩＤＴの電極指総本数をＮ１、不平衡信号端子側に接続されたＩＤＴの電極指総本数Ｎ２とした場合、比率Ｎ２／Ｎ１が５０％～７０％であり、かつ前記ＩＤＴの電極交叉幅（Ｗ）が弾性表面波の波長λに対して４３λ～５８λの範囲にて構成することで、さらに望ましくは、ＩＤＴ－リフレクタ間隔は０．４６λｒ以上、０．５４λｒ以下、もしくは周波数比ｆｒｅｆ／ｆｉｄｔが０．９９３以上、１．００３以下の範囲にて構成することで、不平衡信号端子と平衡信号端子のインピーダンスの関係が１：２ないし１：３となる弾性表面波装置が得られる。

【００５９】

以下に、実施の第二形態に係る弾性表面波装置について説明する。実施の第二形態では、図１に示す実施の第一形態と同一の機能を有する部材については、図１２に示すように、同一の部材番号を付与して、それらの説明を省いた。

【００６０】

実施の第二形態の構成においては、図１２に示すように、弾性表面波素子３０１におけるＩＤＴ３０４とＩＤＴ３０５が並列に接続される点４２８にて、弾性表面波共振子４３１が直列に接続されている。

【００６１】

同様に、弾性表面波素子３０２についても点４２９にて、弾性表面波共振子４３２が直列に接続されている。弾性表面波共振子４３１（４３２）は伝搬路に沿ってＩＤＴ４３３（４３６）を配置し、このＩＤＴを挟み込むように、リフレクタ４３４（４３７）、４３５（４３８）を配置することで形成されている。尚、弾性表面波共振子４３１、４３２の詳細な設計は、弾性表面波共振子のＩＤＴのピッチで決まる波長をそれぞれλｔｉ、リフレクタのピッチで決まる波長をそれぞれλｔｒとすると、以下の通りである。

・交叉幅：１００μｍ
・ＩＤＴ本数：１６１本
・リフレクタ本数：１０本
・ＩＤＴ－リフレクタ間隔：０．５０λｔｒ
・ＩＤＴｄｕｔｙ：０．７０
・リフレクタｄｕｔｙ：０．７０
・（ＩＤＴ周波数ｆｔｉ）／（リフレクタ周波数ｆｔｒ）＝１．０

実施の第二形態の構成での周波数特性を図１３に、インピーダンス特性を図１４（ａ）、図１４（ｂ）に、反射特性（ＶＳＷＲ）を図１５にそれぞれ示す。なお、このときの規格化インピーダンスは不平衡端子側が５０Ω、平衡端子側が１００Ωであり、１：２の関係になっている。ｆ＝８８０ＭＨｚのポイントをＸ、ｆ＝９１５ＭＨｚのポイントをＹとして、インピーダンス特性にプロットすると、図１４（ａ）、図１４（ｂ）、図１５に示すように、通過帯域のインピーダンスはＳ１１、Ｓ２２ともに規格化インピーダンスにて整合が取れていると言える。これにより、不平衡信号端子と平衡信号端子のインピーダンスの関係はほぼ１：２となることになる。

【００６２】

また、図１２の構造において、図１３ないし図１５の特性が得られた条件にて、規格化インピーダンスを不平衡信号端子側が５０Ω、平衡信号端子側が１５０Ωとし、１：３の関係としたときの周波数特性を図４０に、インピーダンス特性を図４１（ａ）及び図４１（ｂ）に、反射特性（ＶＳＷＲ）を図４２に、それぞれ示す。

【００６３】

図４０ないし図４２に示すように、平衡信号端子側の規格化インピーダンスを１５０Ωとした場合でも、比較的、Ｓ１１、Ｓ２２ともに整合がとれている。このことにより、本実施の第二形態の構成にて設計すれば、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３とすることも可能と言える。

【００６４】

このときの各弾性表面波共振子４３１、４３２の詳細な設計は、弾性表面波共振子のＩＤ

Ｔのピッチで決まる波長をそれぞれλｔｉ、リフレクタのピッチで決まる波長をそれぞれλｔｒとすると、以下の通りである。
・交叉幅：１００μｍ
・ＩＤＴ本数：１６１本
・リフレクタ本数：１０本
・ＩＤＴ－リフレクタ間隔：０．５０λｔｒ
・ＩＤＴｄｕｔｙ：０．７０
・リフレクタｄｕｔｙ：０．７０
・（ＩＤＴ周波数ｆｔｉ）／（リフレクタ周波数ｆｔｒ）＝１．０
次に、実施の第二形態の効果が得られた理由を説明する。まず、弾性表面波共振子４３１、４３２の周波数－インピーダンス特性を図１６に示す。図１６において、インピーダンスが極小になる周波数を共振周波数ｆ１、極大になる点を反共振周波数ｆ２すると、各弾性表面波共振子４３１、４３２はｆ１＝８９５．５ＭＨｚ、ｆ２＝９２８．５ＭＨｚとなっている。直列に弾性表面波共振子を付加した場合、付加された側のインピーダンスは共振周波数ｆ１から反共振周波数ｆ２までの周波数領域は誘導性に働き、それ以外の領域では容量性に働く。

【００６５】
また、本実施の形態のような３ＩＤＴ型の縦結合共振子型の弾性表面波素子では通過帯域を形成するために、図１７及び図１８に示すように３つの共振モードを用いている。図１７は実施の第二形態の構成における弾性表面波素子３０１と弾性表面波素子４０２のみでの特性の共振モードを分かりやすくするため、故意にインピーダンスを外して測定した周波数特性である。また、図１８にそれぞれの有効電流の強度分布を示す。

【００６６】
Ａ点にあたる最も周波数の低いレスポンスは２次モードと呼ばれ、有効電流分布において２つの節をもつ共振モードである。Ｂ点にあたる帯域中央のレスポンスは０次モードと呼ばれ、有効電流強度分布において節をもたないモードである。Ｃ点の最も周波数の高いレスポンスは、ＩＤＴ－ＩＤＴ間隔部に弾性表面波の強度分布のピークをもつ定在波共振モード（以下、高域側のモードとする）である。

【００６７】
実施の第二形態の場合、２次モード周波数は８７６ＭＨｚ、０次モード周波数は９０１ＭＨｚ、高域側のモードは９２２．５ＭＨｚである。つまり、弾性表面波素子４０１と弾性表面波素子４０２の０次モード周波数及び高域側のモードは、弾性表面波共振子４３１、４３２の共振周波数ｆ１、反共振周波数ｆ２の間に位置することになる。

【００６８】
ここで、実施の第二形態の構成にて、各弾性表面波素子４０１、４０２のみの状態から、弾性表面波共振子４３１、４３２を付加した時のインピーダンス特性の変化を周波数域に分けて見ていく。図１９（ａ）及び図１９（ｂ）は８８０ＭＨｚから８９５．５ＭＨｚ（共振周波数ｆ１）にかけてのインピーダンス特性の変化を、図２０（ａ）及び図２０（ｂ）は８９５．５ＭＨｚ（共振周波数ｆ１）から９２８・５ＭＨｚ（反共振周波数ｆ２）にかけてのインピーダンスの変化を示している。

【００６９】
図１９及び図２０に注目すると、通過帯域低域側の８８０ＭＨｚ～８９５．５ＭＨｚにかけては、弾性表面波共振子は容量性に働くため、Ｓ２２のインピーダンスは容量性にシフトする。一方、通過帯域高域側にあたる８９５．５ＭＨｚから９２８．５ＭＨｚにかけては、弾性表面波共振子は誘導性に働くため、Ｓ２２のインピーダンスは実軸上に持ち上がる格好になり、整合状態がよくなる。つまり、通過帯域高域側を形成するための０次、高域モードにかけての周波数帯に、弾性表面波共振子が誘導性に働くように挿入することで、入出力のインピーダンスの関係はほぼ１：２ないし１：３となり、かつ通過帯域外において高減衰な特性を得ることができる。

【００７０】

本実施の形態では、平衡信号端子側のみに各弾性表面波共振子４３１、４３２をそれぞれ接続して構成しているが、弾性表面波共振子は平衡信号側、不平衡信号側の両方に、また複数個ずつ接続してもかまわない。本実施の形態における別の例を図２１、図２２にそれぞれ示す。

【００７１】

また、実施の第二形態では２つの弾性表面波フィルタを用いているが、図２５及び図２６のように１つの弾性表面波フィルタによる平衡－不平衡変換機能を有する弾性表面波素子においても同じことが言える。

【００７２】

以上説明したように実施の第二形態では、平衡－不平衡変換機能を有する弾性表面波装置において、平衡信号端子側に接続されたＩＤＴの電極指総本数をＮ１、不平衡信号端子側に接続されたＩＤＴの電極指総本数Ｎ２とした場合、比率Ｎ２／Ｎ１が５０～７０％であり、かつ前記ＩＤＴの電極交叉幅（Ｗ）が弾性表面波の波長λＩに対して４３λＩ～５８λＩの範囲にて構成することで、さらに望ましくはＩＤＴ－リフレクタ間隔は０．４６λｒ以上、０．５４λｒ以下、もしくは周波数比ｆｒｅｆ／ｆｉｄｔが０．９９３以上１．００３以下の範囲にて構成し、少なくと平衡側端子に接続されたＩＤＴに少なくとも一つの弾性表面波共振子を電気的に直列に接続することで、不平衡信号端子と平衡信号端子のインピーダンスの関係が１：２ないし１：３となり、また、通過帯域外の減衰量に優れた特性の弾性表面波装置が得られる。

【００７３】

次に、上記実施の各形態に記載の弾性表面波装置を搭載した通信装置について図２７に基づき説明する。上記通信装置６００は、受信を行うレシーバ側（Ｒｘ側）として、アンテナ６０１、アンテナ共用部／ＲＦＴｏＰフィルタ６０２、アンプ６０３、Ｒｘ段間フィルタ６０４、ミキサ６０５、１ｓｔＩＦフィルタ６０６、ミキサ６０７、２ｎｄＩＦフィルタ６０８、１ｓｔ＋２ｎｄローカルシンセサイザ６１１、ＴＣＸＯ（ｔｅｍｐｅｒａｔｕｒｅ ｃｏｍｐｅｎｓａｔｅｄ ｃｒｙｓｔａｌ ｏｓｃｉｌｌａｔｏｒ（温度補償型水晶発振器））６１２、デバイダ６１３、ローカルフィルタ６１４を備えて構成されている。

【００７４】

Ｒｘ段間フィルタ６０４からミキサ６０５へは、図２７に二本線で示したように、バランス性を確保するために各平衡信号にて送信することが好ましい。

【００７５】

また、上記通信装置６００は、送信を行うトランシーバ側（Ｔｘ側）として、上記アンテナ６０１及び上記アンテナ共用部／ＲＦＴｏＰフィルタ６０２を共用するとともに、ＴｘＩＦフィルタ６２１、ミキサ６２２、Ｔｘ段間フィルタ６２３、アンプ６２４、カプラ６２５、アイソレータ６２６、ＡＰＣ（ａｕｔｏｍａｔｉｃ ｐｏｗｅｒ ｃｏｎｔｒｏｌ（自動出力制御））６２７を備えて構成されている。

【００７６】

そして、上記のＲｘ段間フィルタ６０４、１ｓｔＩＦフィルタ６０６、ＴｘＩＦフィルタ６２１、Ｔｘ段間フィルタ６２３には、上述した本実施の形態に記載の弾性表面波装置が好適に利用できる。

【００７７】

本発明に係る弾性表面波装置は、フィルタ機能と共に平衡型－不平衡変換機能を備えることができ、その上、不平衡信号端子と平衡信号端子のインピーダンスの関係を１：２ないし１：３にでき、また、通過帯域外の減衰量に優れた特性を有するものである。よって、上記弾性表面波装置を有する本発明の通信装置は、伝送特性を向上できるものとなっている。

【００７８】

【発明の効果】

本発明の弾性表面波装置は、以上のように、平衡信号端子側に接続されたＩＤＴの電極指

総本数をＮ１、不平衡信号端子側に接続されたＩＤＴの電極指総本数Ｎ２とした場合、比率Ｎ２／Ｎ１が５０～７０％であり、かつ前記ＩＤＴの電極交叉幅（Ｗ）が弾性表面波の波長λに対して４３λ～５８λの範囲にて構成することで、さらに望ましくはＩＤＴ－リフレクタ間隔は０．４６λｒ以上０．５４λｒ以下もしくは周波数比ｆｒｅｆ／ｆｉｄｔが０．９９３以上１．００３以下の範囲にて構成することで、不平衡信号端子と平衡信号端子のインピーダンスの関係が１：２ないし１：３にできる弾性表面波装置が得られる。

【００７９】

さらには、少なくと平衡側端子に接続されたＩＤＴに一つの弾性表面波共振子を電気的に直列に接続することで、不平衡信号端子と平衡信号端子のインピーダンスの関係を１：２ないし１：３にでき、また、帯域外減衰量の優れた特性の弾性表面波装置が得られる。

【図面の簡単な説明】

【図１】本発明に係る実施の第一形態における弾性表面波装置の構成図である。

【図２】上記実施の第一形態の構成にて交叉幅Ｗ／λＩをＸ軸とし、複数の電極指数比Ｎ２／Ｎ１でみた時の比帯域幅の依存性を示すグラフである。

【図３】上記実施の第一形態の構成にて交叉幅Ｗ／λＩをＸ軸とし、複数の電極指数比Ｎ２／Ｎ１でみた時のＶＳＷＲの依存性を示すグラフである。

【図４】上記実施の第一形態の構成にて電極指数比Ｎ２／Ｎ１をＸ軸とし、複数のＩＤＴ－リフレクタ間隔でみた時のＶＳＷＲの依存性を示すグラフである。

【図５】上記実施の第一形態の構成にて電極指数比Ｎ２／Ｎ１をＸ軸とし、複数のＩＤＴ－リフレクタ間隔でみた時の比帯域幅の依存性を示すグラフである。

【図６】上記実施の第一形態の構成にてＩＤＴ－リフレクタ間隔をＸ軸とし、複数の周波数比ｆｒｅｆ／ｆｉｄｔでみた時のＶＳＷＲの依存性を示すグラフである。

【図７】上記実施の第一形態の構成にてＩＤＴ－リフレクタ間隔をＸ軸とし、複数の周波数比ｆｒｅｆ／ｆｉｄｔでみた時の比帯域幅の依存性を示すグラフである。

【図８】上記実施の第一形態の構成での代表的な周波数特性を示すグラフである。

【図９】上記実施の第一形態の構成での代表的なインピーダンス特性を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１００Ωのときである。

【図１０】上記実施の第一形態の構成での代表的な反射（ＶＳＷＲ）特性を示すグラフである。

【図１１】上記実施の第一形態における別の変形例の弾性表面波装置を示す概略構成図である。

【図１２】本発明に係る実施の第二形態における弾性表面波装置の概略構成図である。

【図１３】上記実施の第二形態の構成での代表的な周波数特性を示すグラフである。

【図１４】上記実施の第二形態の構成での代表的なインピーダンス特性を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１００Ωのときである。

【図１５】上記実施の第二形態の構成での代表的な反射（ＶＳＷＲ）特性を示すグラフである。

【図１６】上記実施の第二形態における弾性表面波装置に用いた弾性表面波共振子の周波数－インピーダンス特性を示すグラフである。

【図１７】上記実施の第二形態における弾性表面波装置に用いた弾性表面波素子の各共振モードを示すグラフである。

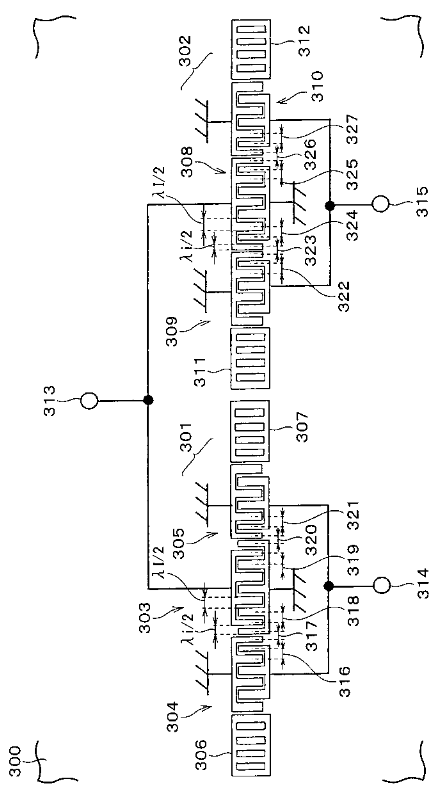
【図１８】上記各共振モードの有効電流分布を示すものであって、（ａ）はＩＤＴの概略構成図、（ｂ）は上記ＩＤＴの配置に対応させた各共振モードを示すグラフである。

【図１９】上記実施の第二形態の構成（共振子有）と実施の第二形態の構成から共振子を省いた構成（共振子無）の時の各インピーダンス特性（８８０ＭＨｚ～８９５．５ＭＨｚ、低域側）を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１００Ωのときである。

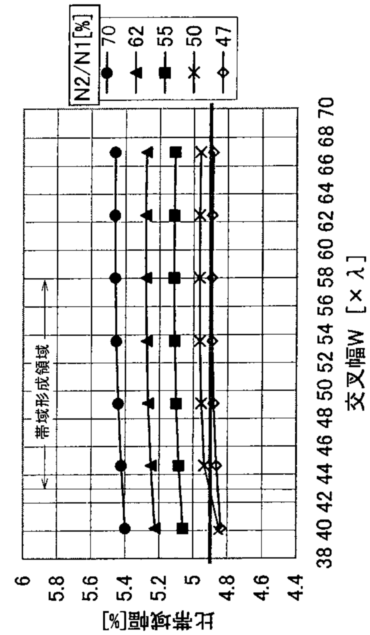
【図２０】上記実施の第二形態の構成（共振子有）と実施の第二形態の構成から共振子を

省いた構成（共振子無）の時の各インピーダンス特性（８９５．５ＭＨｚ～９２８．５ＭＨｚ、高域側）を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１００Ωのときである。
【図２１】上記実施の第二形態における別の変形例に係る弾性表面波装置の概略構成図である。
【図２２】上記実施の第二形態におけるさらに別の例の概略構成図である。
【図２３】前記実施の第一形態のさらに別の例の概略構成図である。
【図２４】上記実施の第一形態のさらに別の例の概略構成図である。
【図２５】上記実施の第二形態のさらに別の例の概略構成図である。
【図２６】上記実施の第二形態におけるさらに別の例の概略構成図である。
【図２７】本発明の通信装置の回路ブロック図である。
【図２８】従来の、不平衡－平衡入出力対応の弾性表面波装置の概略構成図である。
【図２９】上記従来（入出力インピーダンスが約４倍異なる特性の例）での周波数特性を示すグラフである。
【図３０】上記従来（入出力インピーダンスが約４倍異なる特性の例）でのインピーダンス特性を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが２００Ωのときである。
【図３１】従来の他の、入出力のインピーダンスが異なる弾性表面波装置の概略構成図である。
【図３２】上記図３１の構成のうち、１つの弾性表面波フィルタのみの時の周波数特性を示すグラフである。
【図３３】上記図３１の構成での周波数特性を示すグラフである。
【図３４】従来のさらに他の弾性表面波装置（入出力インピーダンスが約２倍異なる特性の例）と外部素子付加時の周波数特性を示すグラフである。
【図３５】上記従来（入出力インピーダンスが約２倍異なる特性の例）と外部素子付加時のインピーダンス特性を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１００Ωのときである。
【図３６】上記従来において、外部素子付加時の回路図である。
【図３７】前記実施の第一形態において、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３としたときの、周波数特性を示すグラフである。
【図３８】前記実施の第一形態において、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３としたときの、インピーダンス特性を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１５０Ωのときである。
【図３９】前記実施の第一形態において、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３としたときの、反射特性（ＶＳＷＲ）を示すグラフである。
【図４０】前記実施の第二形態において、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３としたときの、周波数特性を示すグラフである。
【図４１】前記実施の第二形態において、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３としたときの、インピーダンス特性を示すグラフであって、（ａ）は規格化インピーダンスが５０Ωのとき、（ｂ）は規格化インピーダンスが１５０Ωのときである。
【図４２】前記実施の第二形態において、不平衡信号端子と平衡信号端子とのインピーダンスの関係をほぼ１：３としたときの、反射特性（ＶＳＷＲ）を示すグラフである。
【符号の説明】
３０３、３０４、３０５、３０８、３０９、３１０　　ＩＤＴ（くし型電極部）３１３　不平衡信号端子
３１４、３１４　　平衡信号端子側

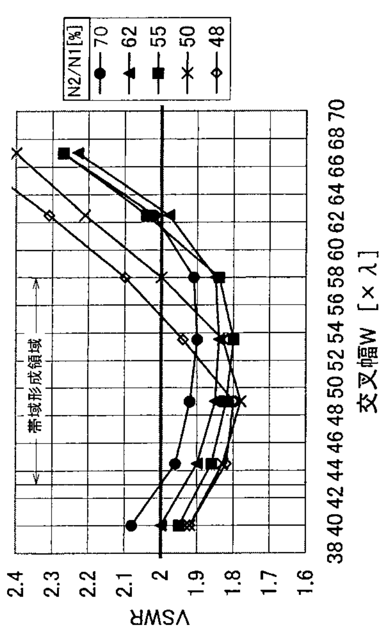
【図１】


300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
λi/2
λi/2
λi/2
λi/2

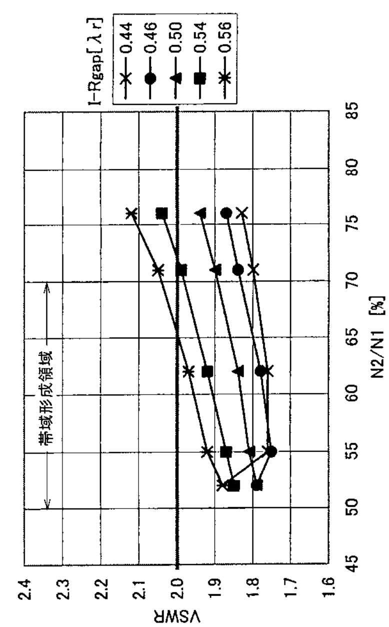
【図２】


N2/N1[%]
70
62
55
50
47
帯域形成領域
比帯域幅[%]
交叉幅W [×λ]

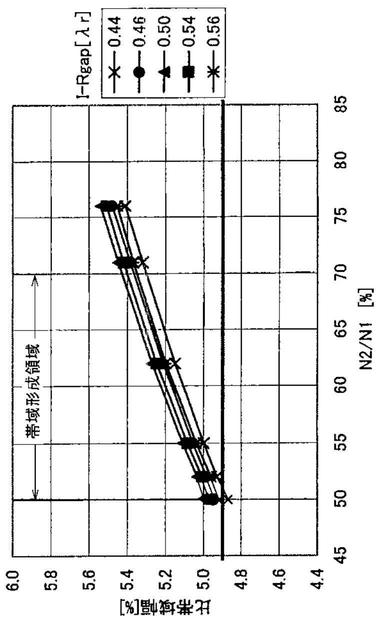
【図３】


N2/N1[%]
70
62
55
50
48
帯域形成領域
VSWR
交叉幅W [×λ]

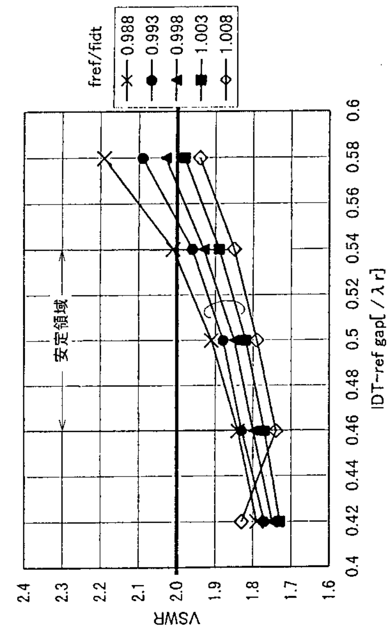
【図４】


I-Rgap[λr]
0.44
0.46
0.50
0.54
0.56
帯域形成領域
VSWR
N2/N1 [%]

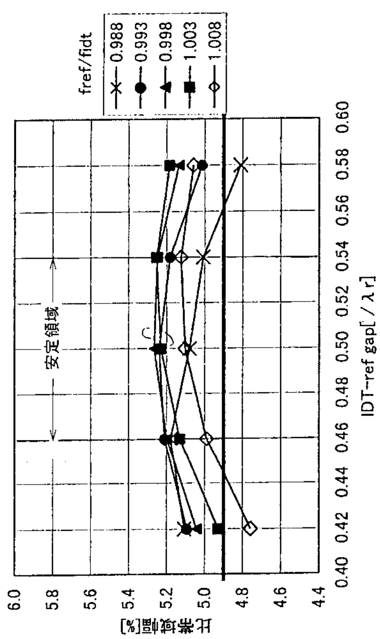
【図５】


I-Rgap[λr]
0.44
0.46
0.50
0.54
0.56
帯域形成領域
N2/N1 [%]
比帯域幅[%]

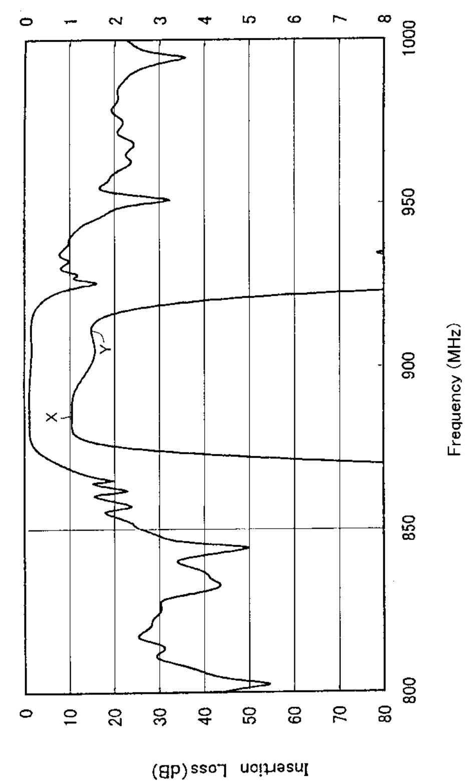
【図６】


fref/fidt
0.988
0.993
0.998
1.003
1.008
安定領域
IDT-ref gap[/λr]
VSWR

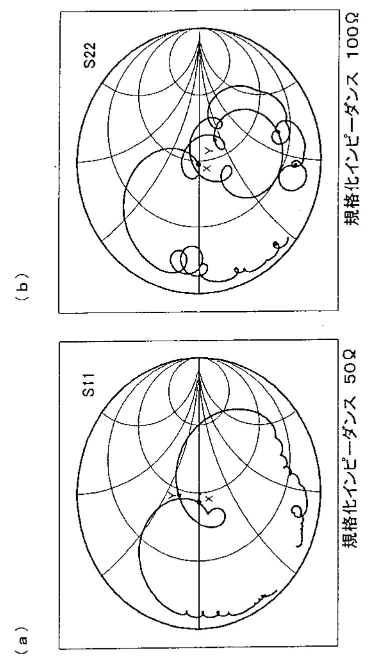
【図７】


fref/fidt
0.988
0.993
0.998
1.003
1.008
安定領域
IDT-ref gap[/λr]
比帯域幅[%]

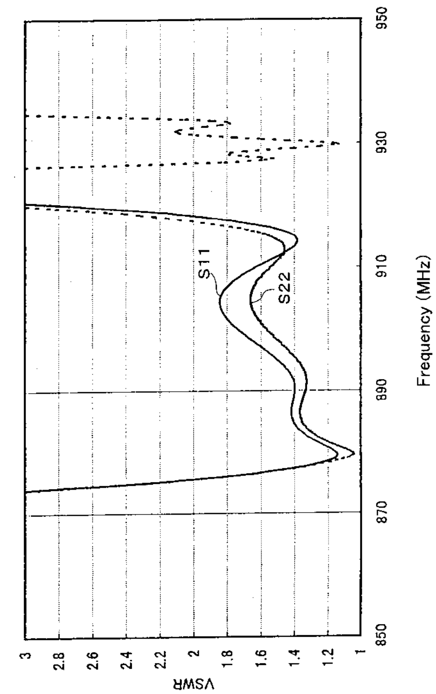
【図８】


X
Y
Frequency (MHz)
Insertion Loss (dB)

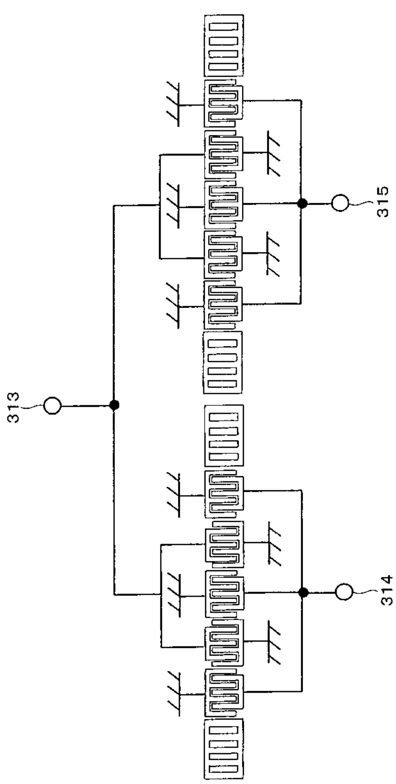
【図９】



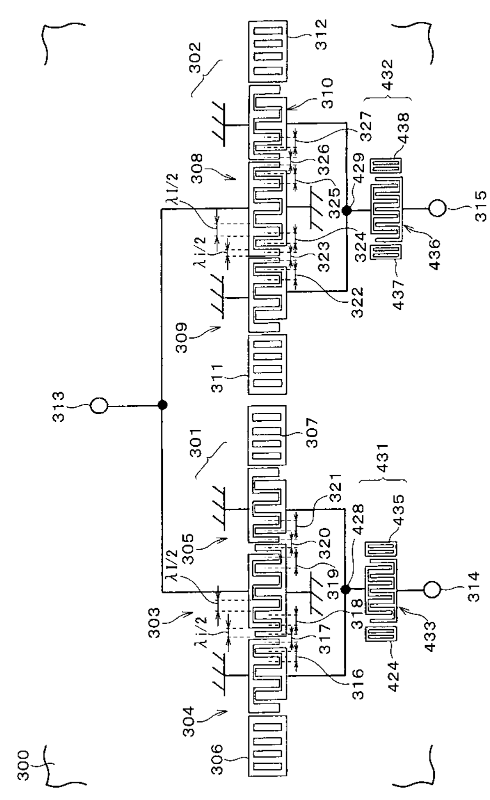
【図１０】



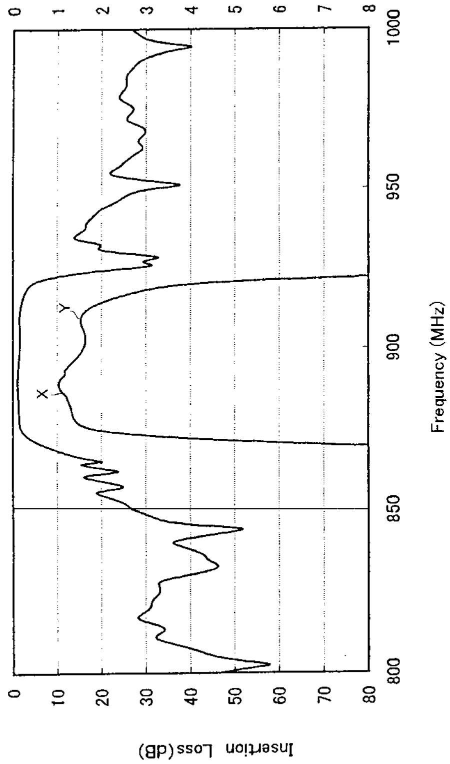
【図１１】



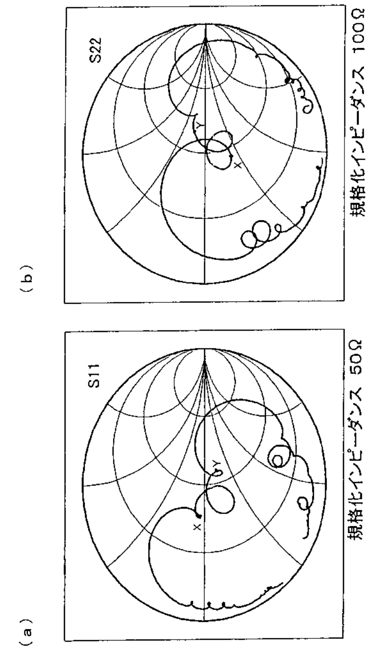
【図１２】



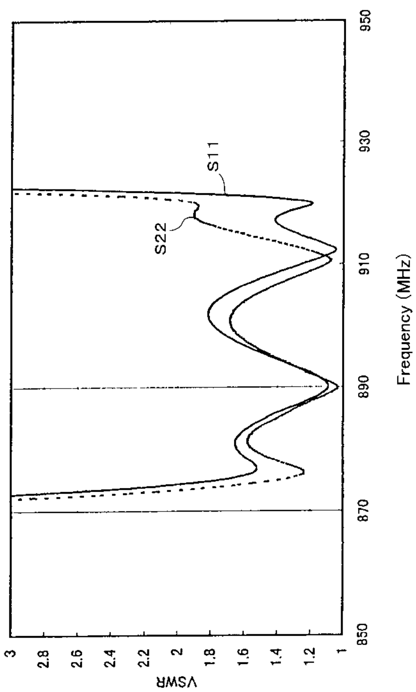
【図１３】



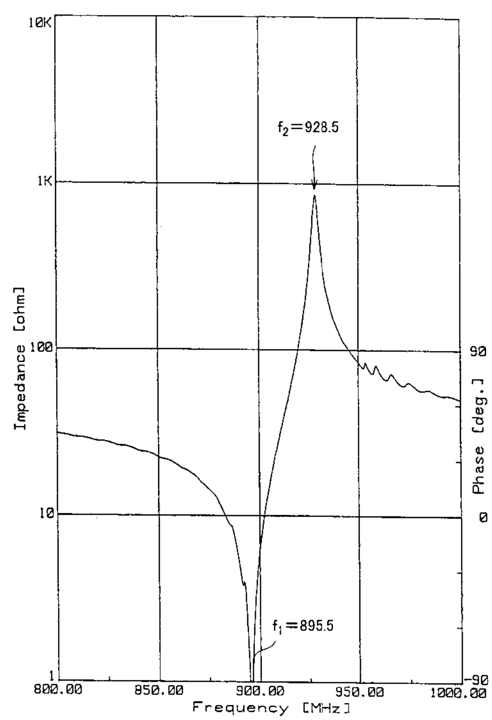
【図１４】



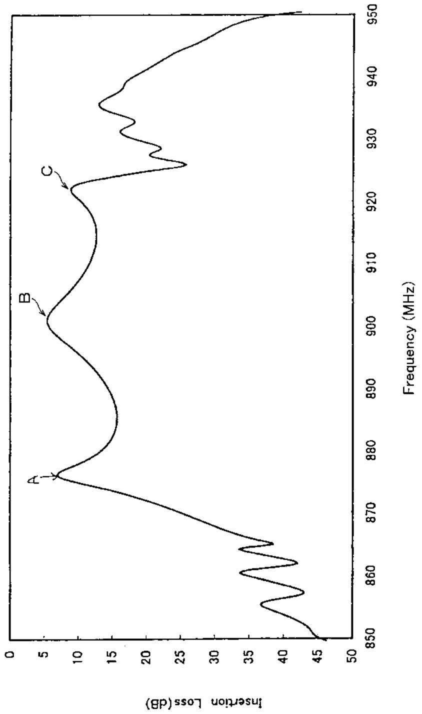
【図１５】



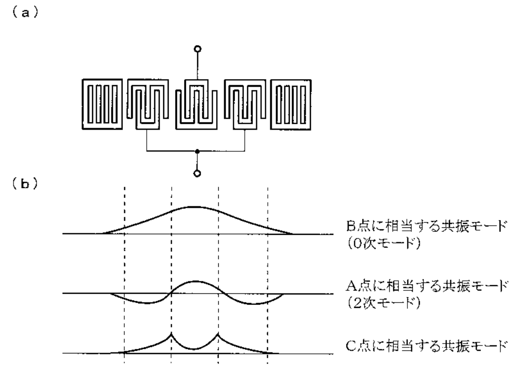
【図１６】



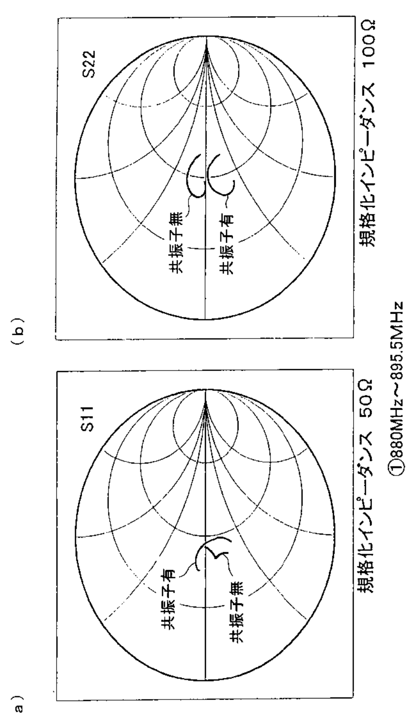
【図１７】



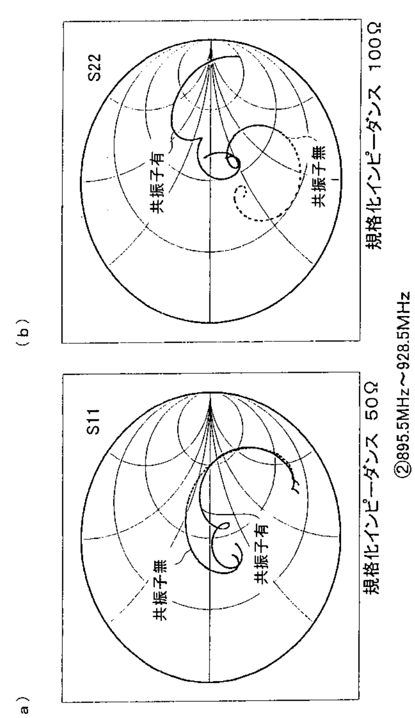
【図１８】



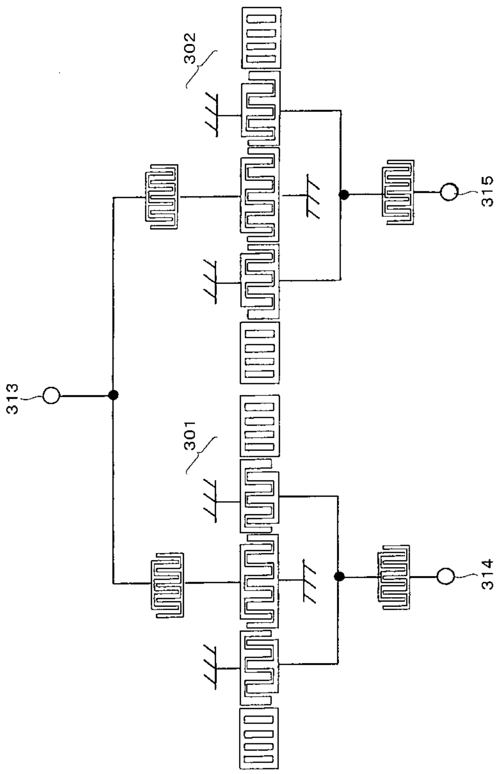
【図１９】



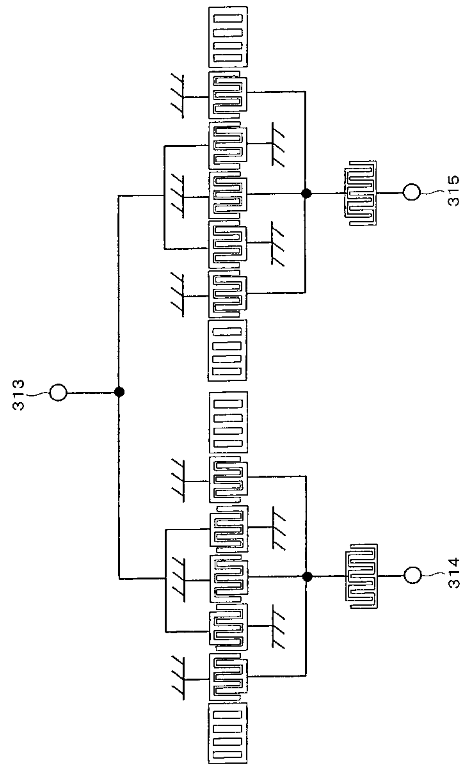
【図２０】



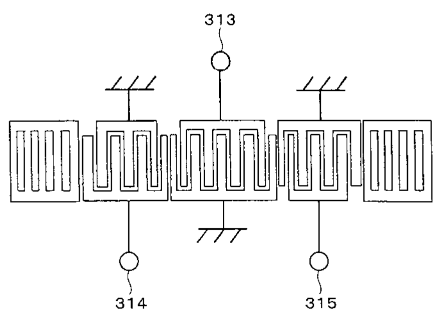
【図２１】



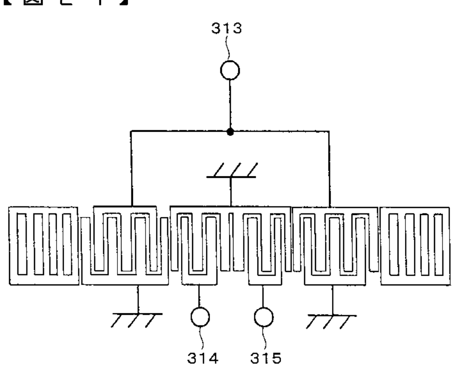
【図２２】



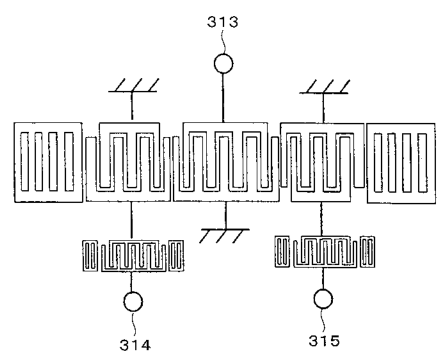
【図２３】



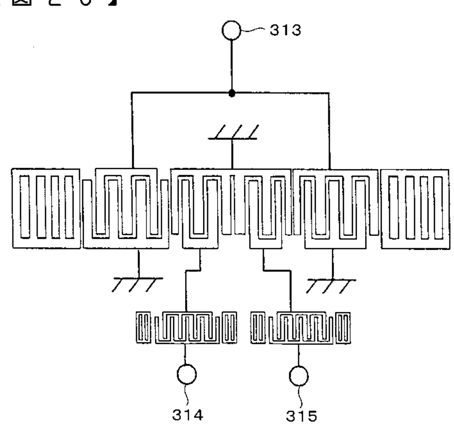
【図２４】



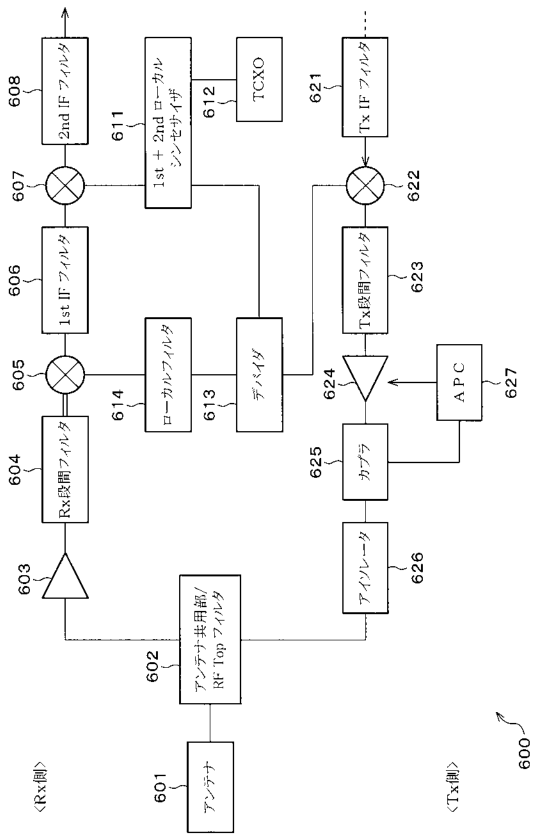
【図２５】



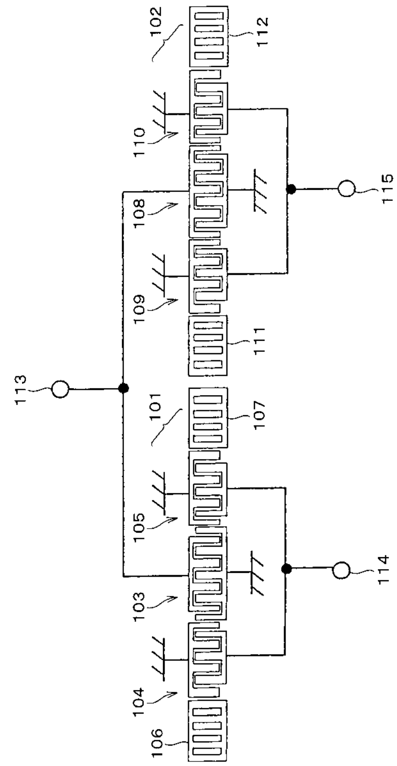
【図２６】



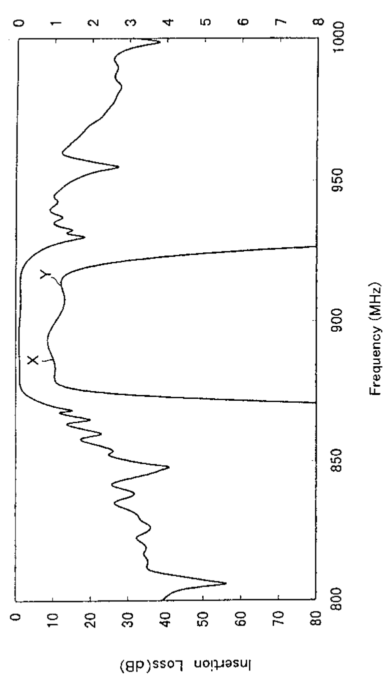
【図２７】



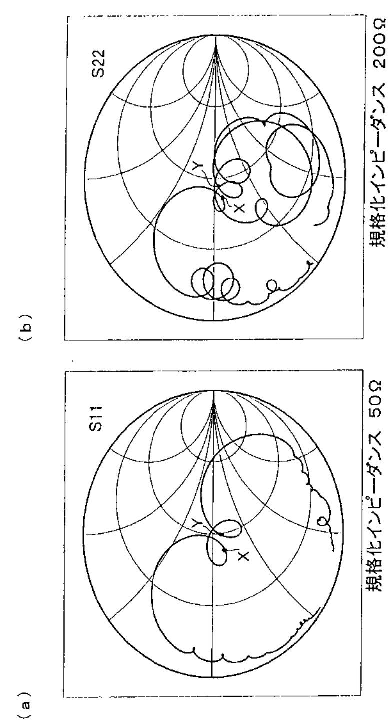
【図２８】



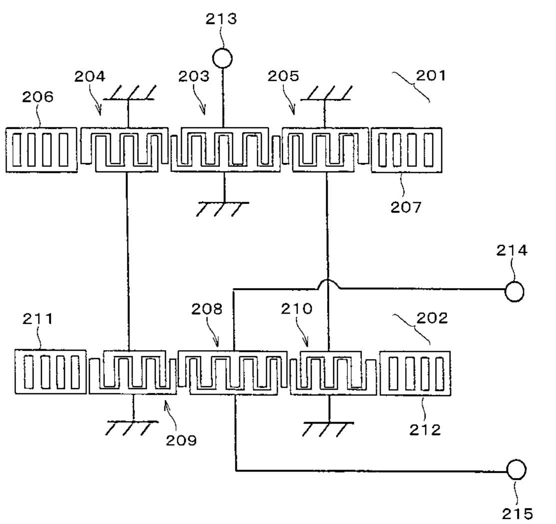
【図２９】



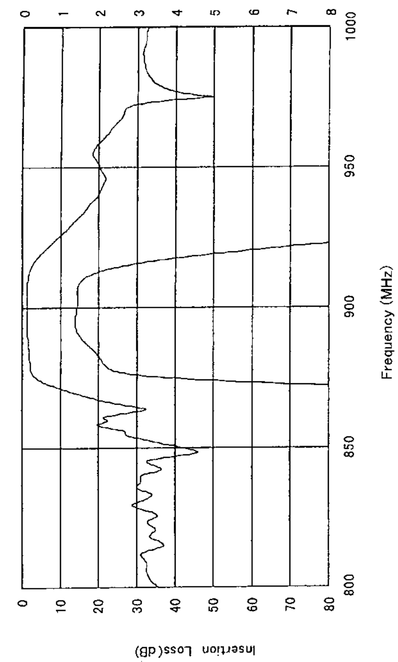
【図３０】



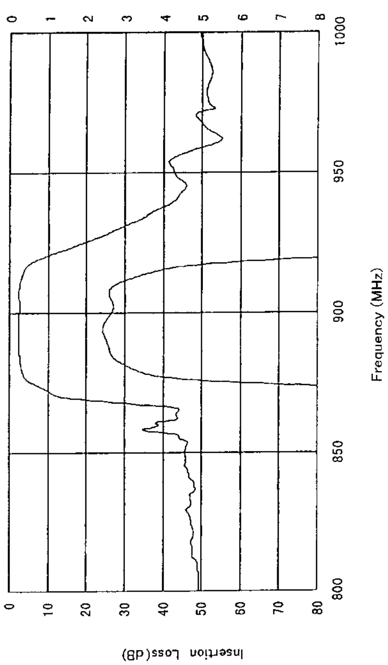
【図31】



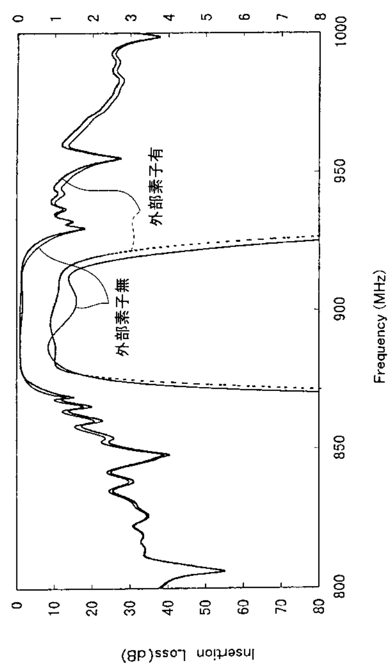
【図32】



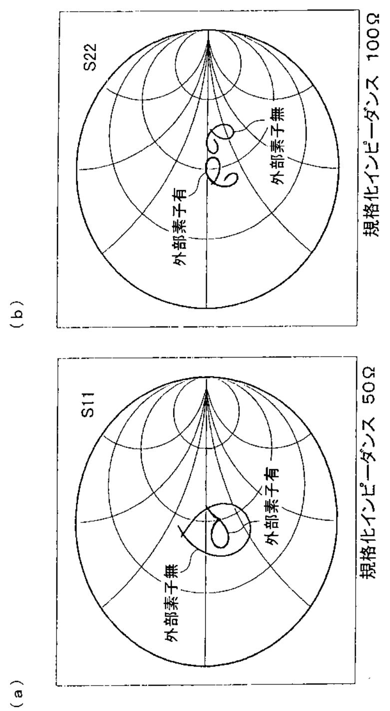
【図33】



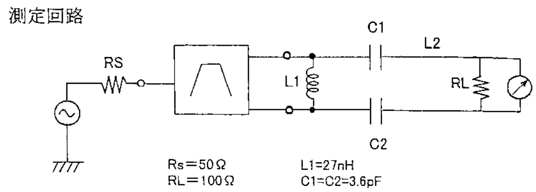
【図34】



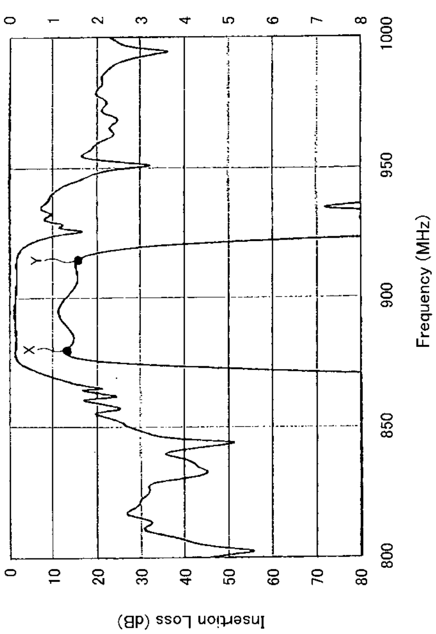
【図３５】



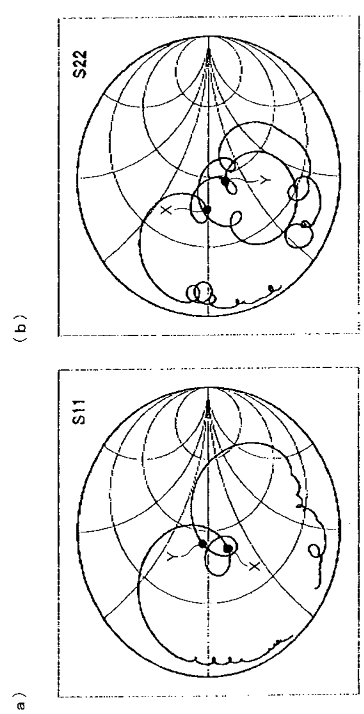
【図３６】



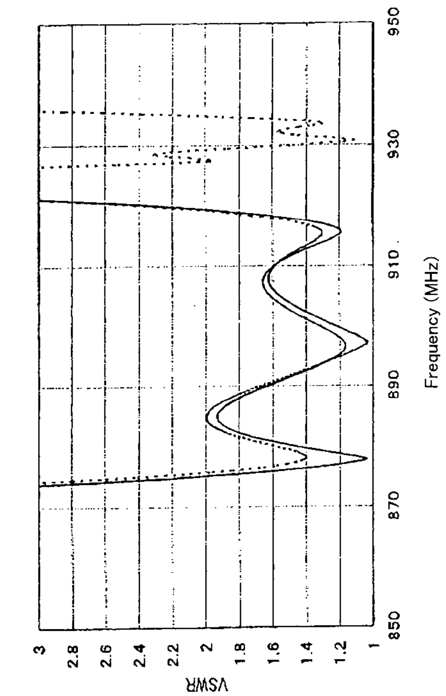
【図３７】



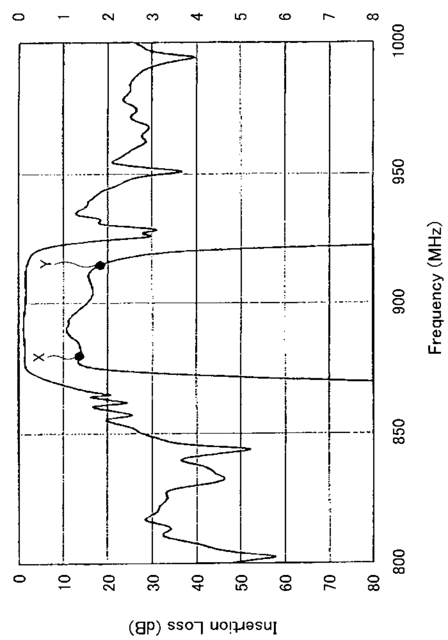
【図３８】



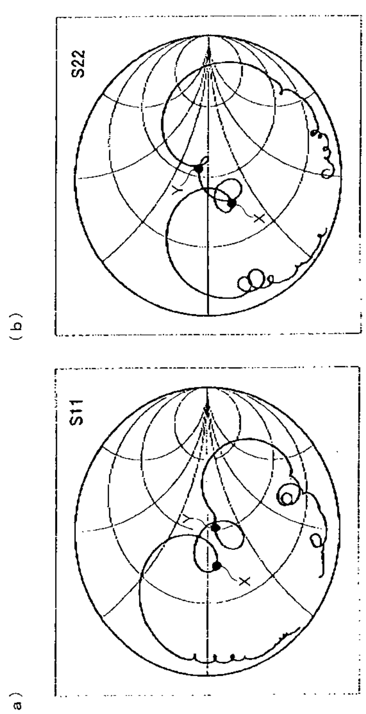
【図３９】



【図４０】



【図４１】



【図４２】